ATTACHMENT 1
NGG Procedure Approval/History Form
Page 1 of 2

ORIGINATOR

☒ New Procedure ☐ Revision ☐ Delete Procedure ☐ Temp. Change ☐ Editorial

Location: BYRON Procedure Number: BVP 800-44 Revision: 0

Procedure Title: FEEDWATER VENTURI CALIBRATION UNIT 1 AND 2

Special Distribution Requirement: ☒ N/A
☐ Before, ☐ At the same time as, ☐ After

Electronic File Location: working\bvp\800-44.doc ER# (if applicable) 9911897

NGG Document(s) Affected (attach addition sheets if required)
Revised: Superceded: Voided:

Originator: [signature] Date: 4-3-00 Location/Ext: 2194

TECHNICAL REVIEW (per NSP-AP-3001) Required: Y/N (Y circled) Category/Level of Use: 1 2 3 (2 circled)

Training Required: Y/N (N circled) Review Requirements Require Revision: Y/N (N circled) Validation Required: Y/N

Validation Signature	Print	Date	

Reviews/Special Controls Required: (list) A, B, G R.F. 4/28/00 SCM Approval

Signature	Print	Date	Discipline
[signature]	James R. Harkness	5/1/00	A, G
[signature]	L D Bunner	5/2/00	A, B, G
[signature]	Harlan Kats	5-2-00	

10CFR 50.59 Screening or Evaluation (or equivalent Reg. Review): ☐ N/A ☒ Complete ☐ Exempt per

Plant Operations Review Committee Required: Y/N (Y circled) If yes, 00 - 42
PORC Number

AUTHORIZATION: [signature] /SM Date: 5/11/00 Impl. Date:

TEMPORARY CHANGE AUTHORIZATION ONLY:

SEAM: SRO:

Proc. Clerk/Date WPT/Date: [initials] 5/1/00 5/1/00 Proofread/Date

XBVP0299 copied from BVP 800-42 XBVP0298

P-4

ATTACHMENT 1
NGG Procedure Approval/History Form
Page 2 of 2

Procedure Number: BVP 800-44 Revision: 0 Page: 1 of 1

Procedure Title: FEEDWATER VENTURE CALIBRATION UNIT 1 + UNIT 2

NOTE: The description of change(s) should be written to provide information necessary for the procedure user to understand the changes and the impact they have on the performance of work.

Describe changes: (attach additional pages as necessary)

NEW PROCEDURE

State the purpose of the changes: (attach additional pages as necessary)

NEW PROCEDURE

(attach additional sheets if needed)

ATTACHMENT 2
NGG Procedure Implementation
Page 1 of 1

Implementation of new or revised procedures can be simple, complex, or range in between. The manager owning the procedure is responsible to provide guidance to assist sites in efficiently implementing procedure changes by filling out this form.

- For standard procedures, the Corporate Functional Area Manager will complete this form with input from site counterparts.
- For other procedures, the responsible Station Functional Area Manager will complete this form.

Managers implementing procedure changes may alter the guidance contained in this attachment to achieve more efficient and effective implementation. Changes to guidance for standard procedures should be shared with the Corporate Functional Area Manager.

For ALL changes:

Notify all other departments affected by this change to ensure needed implementation actions are taken. List the departments below: OPS, I&C, SED

List all standard procedures deleted (Corporate functional Area Manager): NONE

State how site personnel will be notified of changes (POD, bulletins, OJT, FOCUS, etc.): TR's, FOCUS

State training that will be completed by line supervision in the field (tailgates, briefs, required reading, OJT, etc.):
TR's

For COMPLEX or EXTENSIVE changes:
If an implementation team is to be used, record key team actions and dates from the approved implementation plan.

Key Team Actions: ______ Dates: ______

If formal training is to be used, record topic(s) and dates:

Topics: ______ Dates: ______

NOTE: TRAINING IN THE FIELD BY LINE MANAGEMENT OR A IMPLEMENTATION TEAM IS NORMALLY MORE EFFECTIVE THAN FORMAL CLASSROOM TRAINING FOR MOST CHANGES. IF FORMAL TRAINING IS REQUIRED, A FORMAL TRAINING REQUEST MUST BE SUBMITTED.

(attach additional sheets if needed)

ATTACHMENT 3
NGG Procedure Validation
Page 1 of 1

Location: BYRON Procedure Number: BVP 900-44 Revision: Ø

☐ Mockup/Simulator ☒ Field Walkdown ☐ Benchtop Review ☐ First Time Use

		Yes	No	N/A
1.	Is the procedure easy to use and does it flow well? Such as:			
	- Sequence correct	☒	☐	☐
	- Bypassing	☒	☐	
	- Written to the appropriate level of detail	☒	☐	
	- Computation of values are easy to perform	☒	☐	☐
2.	Procedure is flexible enough to use	☒	☐	
3.	Are the figures, charts, and graphs sufficient, legible and easy to use?	☒	☐	☐
4.	Is the purpose of the procedure clearly stated?	☒	☐	
5.	Is adequate acceptance criteria provided?	☒	☐	
6.	Is the procedure technically correct?	☒	☐	☐
	- Instrumentation specified is correct	☒	☐	
	- All necessary steps and actions are present	☒	☐	☐

Validation Participants

Name	DAVID EDER (PRINT)	Location	BYRON	Date	4/28/00
Name	Harlan Kats (PRINT)	Location	Byron	Date	4/28/00
Name	(PRINT)	Location		Date	

ATTACHMENT 4
NGG Procedure Process Checklist
Page 1 of 1

Document Number: BVP 800-4 8 DMZ 5/11/00 Revision: Ø

ACTION	(✓) OR N/A
EDITORIAL CHANGES - Procedure Editorial Change criteria ☐ All answers are "No" – proceed with editorial change ☐ Any answer is "Yes" – full approval is required for change.	
SPELL CHECK - Performed on entire document.	✓
PROCEDURE TYPE/NUMBER - Indicated on upper right of each procedure page.	
PROCEDURE NUMBER – Indicated and the same on upper right of each procedure page.	
REVISION NUMBER – Raised AND indicated on upper right of each procedure page.	
PAGE NUMBER - Indicated on upper right of each procedure page.	
IF computer used, THEN Electronic file location recorded on Attachment 1,Procedure Approval/History Form, OR file submitted on disc.	
10 CFR 50.59 SAFETY EVALUATION/SCREENING - Signatures obtained from qualified individuals.	
REVIEWS/SPECIAL CONTROLS – Identified on Attachment 1, Procedure Approval Form/History and Completed.	
INDEPENDENT TECHNICAL/CROSS DISCIPLINE REVIEW - Participants have signed, dated and indicated review disciplines.	
PORC – Indicated IF required.	
TRAINING – Indicated on Attachment 1, NGG Procedure Approval/History Form IF required, IF yes, then specify type: ____________.	
PORC COMPLETE - PORC number documented.	
ATTACHMENT TITLES & SUPPLEMENTS SECTION - Should match word for word.	
RECORD RETENTION – Department Record Custodian has been contacted to resolve potential retention issues as required.	
IMPLEMENTATION DATE – Indicated on attachment 1, Document Approval/History Form has been scheduled.	
Intentionally left blank	

10 CFR 50.59 Safety Evaluation Form

Tracking No.: 6G-00-0079

1. Station/Unit: Byron/1&2 Applicable Modes: All

   Other relevant plant conditions: N/A

2. List the documents implementing the proposed change. Include Procedure Number(s), Test(s), Experiment(s), etc., (including revision # as appropriate):

   - DCP 9900071(U-1) including DCN 001386I
   - DCP 9900073(U-2) including DCN 001387I
   - DCP 9900505(SSCR # 00-020) Setpoint Change for Unit 2 S/G nozzle flow high Alarm
   - DCP's 9900500,501,502,503(SSCR #s 00-015,016,017,018) Scaling Change for Unit 2 T_{Ave} and Delta T's
   - DCP's 9900499 & 504(SSCR #s 00-014 &019) Scaling Change for Unit 1 and Unit 2 Turbine Impulse Pressure
   - DCP 9900506(SSCR # 00-021) Scaling changes for Unit 2 T_{Ave} / T_{Ref} from 583 to 582.5 degree F(T_{Ref} Program)
   - DCP 9900507(SSCR # 00-022) Scaling changes for Unit 2 T_{ave}/T_{Ref} from 583 to 582.5 degree F(Pressurizer Level Program)
   - DCP 9900508(SSCR # 00-023) Scaling changes for Unit 2 T_{ave}/T_{Ref} from 583 to 582.5 degree F(Steam Dump Control Program)
   - DCP's 9900495,496,497,498(SSCR # 00-010,011,012,013) Scaling Changes for Unit 1 Delta T's
   - Procedure 1BVSR 4.1.4-1 Reactor Coolant System Flow Measurement
   - Procedure 2BVSR 4.1.4-1 Reactor Coolant System Flow Measurement
   - Procedure 1BOSR 3.1.2-1 Calorimetric Calculation Daily Surveillance
   - Procedure 2BOSR 3.1.2-1 Calorimetric Calculation Daily Surveillance
   - BVP 800-43 Feedwater Ultrasonic Instrumentation Connection and Disconnection
   - BVP 800-44 Feedwater Venturi Calibration U-1 and U-2
   - BGP 100-3 Steps to Change Scaling Factor(Load Drop Sheets)
   - BOP Fw-25 Feedwater Flow constant
   - BCB-2 Byron Unit 2 Cycle 9 Figures 33, 33a, 34
   - Operating Aid- Feedwater Flow Measurement

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Tracking No. 6G-00-0079

- BISR 3.2.10-200 Surveillance Calibration of S/G Steam Flow/Feed flow Mismatch Protection Set I and II(FW)
- SSP 00-003 Unit 1 AMAG Implementation
- SSP 00-004 Unit 2 AMAG Implementation with T_{Ave} Reduction
- SE 0001 RS 2.2, Requirements Specification for Byron/Braidwood Calorimetric Package

3. Description and effect of proposed activity:

The DCP's 9900071 and 9900073 listed above permanently installed non-intrusive ultrasonic feedwater flow instrumentation upstream of the flow venturis in the Unit 1(2) steam tunnel. The ultrasonic transducers are mounted to brackets that are bolted to the Feedwater piping, one per Feedwater line. A separate 10 CFR 50.59 Safety Evaluation (6G-99-0044) was developed to document the physical installation of the ultrasonic flow instrumentation.

This 10 CFR 50.59 Safety Evaluation documents the acceptability of the use of the ultrasonic flow measurements in the modification of the calorimetric calculations and the revision or development of the procedures listed in Section 2. To allow for this application, the calorimetric calculations will use a correction factor in the determination of the reactor thermal power for both the plant computer and the daily calorimetric calculations. The software for the plant computer has already been modified to accept this correction factor. The calorimetric software for this application has been Verified and Validated.

During reactor operation, discrete reactor power levels are determined on a continuous basis by the plant computer based on inputs received from various monitoring instruments. Of particular importance to the calorimetric calculations is Feedwater flow. The current calorimetric calculation uses the Feedwater flow as obtained from the Feedwater venturis (FE-510, 520, 530 and 540). The Feedwater venturis use differential pressure between the upstream tap and that at the throat of the venturi. Industry and plant operating experience has shown that during operation, fouling of the venturis may occur. Also, venturi inaccuracies can be introduced by the difference between the Reynolds numbers in the test loops used to determine correction factors for Byron venturis, and the Reynolds numbers in the feedwater lines during the power operation. Fouling of the venturi results in a reduction of the flow cross-section through the throat of the venturis and an increase in the pressure drop through the throat due to the roughness of the fouling scale. Both of these conditions contribute to an indicated Feedwater flow higher than actual. Indicated Feedwater flows that are higher than actual values result in an overly conservative calorimetric reactor power calculation. To address this overly conservative calorimetric reactor power calculation, it is proposed that correction factors be manually input to the plant computer and daily calorimetric calculations to compensate for the Feedwater venturi fouling and other venturi induced measurement uncertainties. The NRC has issued an SER on March 20,2000 accepting CE topical report for use of cross flow ultrasonic flow measurement to correct feedwater flow measurement due to fouling of venturis and thereby calorimetric calculation and calibration of nuclear instrumentation. Although CE/AMAG report is not available to ComEd, the plant-specific Byron AMAG Instrumentation was installed by the vendor in accordance with the installation requirements of the vendor. The plant specific accuracy results are documented in ABB calculations 059-PENG-CALC-084 Rev. 0 for Byron Unit 1 and 159-PENG-CALC-085 for Byron Unit 2.

Installed under the DCPs 9900071 and 9900073 listed in Section 2 are ultrasonic flow measuring devices manufactured and installed by Advanced Measurement and Analysis Group (AMAG). These ultrasonic flow-measuring devices have a higher accuracy than the differential-pressure venturis and are not affected by fouling and other venturi induced measurement uncertainties associated with the venturi flow element. Periodically, using new procedure BVP 800-44 ultrasonic flow measurements for each Feedwater line will be taken. Ratio between the ultrasonic flow measurements and those obtained from the venturis will be calculated and provided to the Operations department. The Operations department is responsible for manually entering these constants into the plant computer to correct for inaccurate Feedwater flow. The plant computer calorimetric software will calculate reactor power using these constants. This same factor will be used in the daily calorimetric calculations. The correction factor will be used in the plant computer and daily calorimetric calculations until a new factor is developed through subsequent ultrasonic Feedwater flow measurements, or when the Operations Shift Supervisor determines that the use of the correction factor is not appropriate based on plant operating conditions and the guidance provided by Operating Aid and Operating procedure BOP FW-25.

DCP 9900505(SSCR # 00-020) changes Unit 2 S/G nozzle flow high Alarm setpoint to account for increased feedwater flow.

DCP's 9900499 & 504(SSCR #s 00-014 &019) Change Turbine Impulse Pressure scaling for Unit 1 and Unit 2 respectively because of increase in steam pressure due to AMAG implementation.

DCP's 9900500,501,502,503(SSCR #s 00-015,016,017,018) Change scaling and setpoint changes for Unit 2 T_{Ave} and Delta T's. Since the T_{hot} cannot be increased on Unit 2, the T_{ref}/T_{ave} will have to be decreased. This will be done as part of AMAG implementation. NFM has evaluated(Reference: Letter # PSS:00-024) dropping T_{avg} from 583 degree F to 582.45 degree F for Unit 2. This drop in T_{Ave} will allow the delta-T increase from 58 degree F to 59.1 degree F.

DCP 9900506(SSCR # 00-021) changes for scaling for Unit 2 T_{Ave}/T_{Ref} from 583 to 582.5 degree F (T_{Ref} Program).

DCP 9900507(SSCR # 00-022) changes scaling for Unit 2 T_{ave}/T_{Ref} from 583 to 582.5 degree F (Pressurizer Level Program).

DCP 9900508(SSCR # 00-023) changes scaling for Unit 2 T_{ave}/T_{Ref} from 583 to 582.5 degree F (Steam Dump Control Program).

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DCP's 9900495,496,497,498(SSCR # 00-010,011,012,013) changes scaling for Unit 1 Delta T's.

Following AMAG implementation on Unit 2, the unit will initially indicate about 98.5% reactor power. Since there is only about 0.8% bite in the last main turbine governor valve we will need to re-open the unit 2 HP FW heater bypass valve (2FW005) to get to 100% reactor power. The process with which to perform this task will be included in the Unit 2 SPP for AMAG implementation. This will require a change to the M-line up for Unit 2 to reflect the OPEN position of this valve.

4. Reason for Proposed Activity:

The proposed activity is undertaken to correct overly conservative reactor thermal power calculations, which result from the Feedwater flow venturi readings that are biased because of fouling and other venturi induced measurement inaccuracies that are associated with the Feedwater venturis. Correction factors will be developed based on Feedwater flow measurements obtained using ultrasonic instruments. The ultrasonic flow measuring devices have a higher degree of accuracy than do the venturis and are not affected by fouling and other venturi induced measurement inaccuracies. Therefore, these measurements can be used to correct the venturi readings (application of correction factors) to obtain more accurate calorimetric reactor thermal power calculations and operate the plant closer to the licensed rating.

5. Review the UFSAR, including Authorized for Use UFSAR changes, Technical Specifications, other relevant SAR documents and Owner-controlled documents and list sections that describe or discuss the affected systems, structures, or components (SSCs) or activities. (Refer to Definition 1.9). List any other controlling documents such as SERs, previous modifications or Safety Evaluations, etc.

Regulatory documents:

- Use of NUMARC/EPRI Report TR-102348, "Guidelines on Licensing Digital Upgrades", in Determining the Acceptability of Performing Analog-to-Digital Replacements Under 10CFR50.59.
- SER from NRC dated March 20, 2000 on ABB/CE Topical Report CENPD-397-P, Rev. 01, "Improved Flow Measurement Accuracy using Cross Flow Ultrasonic Flow Measurement Technology".
- SER from NRC dated March 1, 2000 for Byron and Braidwood Re-Rack (Byron Amendment 112) based on Holtec Report # HI-982094

UFSAR Sections:

Sect. 3.9	Mechanical Systems and Components
Sect. 4.2	Fuel System Design

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Sect. 4.3	Nuclear Design
Sect. 4.4	Thermal and Hydraulic Design
Sect. Attach 4.4.A	
Sect. 6.2	Containment Systems
Sect. 6.3	Emergency Core Cooling System
Sect. 7.2	Reactor Trip System
Sect. 7.7	Control Systems not Required for Safety
Sect. 9.3	Process Auxiliaries
Sect. 10.4	Other Features of Steam and Power Conversion System
Sect. 11.1	Source Terms
Sect. 12.3	Radiation Protection Design Features
Sect. 15.0	Accident Analyses
Sect. 15.1	Increase in Heat Removal by the Secondary System
Sect. 15.2	Decrease in Heat Removal by the Secondary System
Appendix A	Compliance with Regulatory Guides

SER's:

SER-01	Byron SER Section 1 Introduction
SER-04	Byron SER Section 4 Reactor
SER-05	Byron SER Section 5 Reactor Coolant System
SER-06	Byron SER Section 6 Engineered Safety Features
SER-07	Byron SER Section 7 Instrumentation and Controls
SER-10	Byron SER Section 10 Steam and Power Conversion Systems
SER-11	Byron SER Section 11 Radioactive Waste Treatment
SER-15	Byron SER Section 15 Accident Analyses
SER-C	Byron SER Appendix C
SER Supplmnt's	Byron SER Supplements 1 through 8
SER Letters	SER Letters 1998 through 1994

ITS and ITS Bases:

Sect. 2.1.1	Reactor Core Safety Limits
Sect. 3.1.2	Core Reactivity
Sect. 3.2.1	Heat Flux Channel Factor (F_Q)
Sect. 3.2.2	Nuclear Enthalpy Rise Hot Channel Factor ($F^N_{\Delta H}$)
Sect. 3.2.3	Axial Flux Difference (AFD)
Sect. 3.3.1	Reactor Trip System (RTS) Instrumentation
Sect. 3.4.1	RCS Pressure, Temperature and Flow Departure from Nucleate Boiling (DNB) Limits
Sect. 3.4.3	RCS Pressure and Temperature (P/T) Limits
Sect. 3.7.16	Spent Fuel Assembly Storage

Other References:

EPRI TR-112118	Nuclear Feedwater Flow Measurement Application Guide

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Braidwood 50.59 Safety Evaluation BRW-SE-1999-0802

Byron Safety Evaluation 6G-99-0055 Unit 2 T_{Ref} Change from 581° F to 583° F

AMAG Evaluation Report

NED-0-MSD-8	Sensitivity of B/B Calorimetric Calculations
NED-I-EIC-0233	Daily Power Calorimetric Accuracy Calculation
PSS:00-024	NFS Letter Evaluation of Lower T_{Ave} on Byron Unit 2 for AMAG Implementation

UFSAR Change Log (none)

ZY index was searched using following keywords:

- over-power
- calorimetric
- max power
- 102
- fouling
- reactor power

The keywords defined above resulted in a large number of hits, only the sections, which were pertinent, are listed above. The documents and specific sections of the documents identified above were reviewed and no changes to UFSAR text are required.

Technical Specifications Bases (RCS Pressure, Temperature and Flow) states that " any fouling that might bias the RCS flow rate measurement greater than 0.1 % can be detected by monitoring and trending various plant performance parameters. If detected, either the fouling shall be quantified and compensated for in the RCS flow rate measurement or venturi shall be cleaned to eliminate the fouling." The AMAG measurement is used to correct the errors/bias associated with venturi measurement and not necessarily states that the 0.1 % fouling has occurred. Because AMAG measurement does not use the venturi for measuring flow, successive AMAG measurement may provide another method of detecting fouling. If fouling is detected after the AMAG correction is applied, that fouling shall be quantified and compensated for RCS flow rate measurement. This is consistent with the Technical Specifications and therefore the Technical Specifications changes are not required.

6. Describe the functions of the affected systems, structures or components.

Feedwater Venturis are differential pressure devices which utilize two sets of instrument taps each of which are provided with dedicated differential pressure transmitters. The Feedwater flow rate is determined as a function of the differential pressure across the venturi. The flow information is a direct input to the plant computer. The plant computer uses this information for the calorimetric calculations.

The Plant Computer accepts input from various plant instruments, including flow information from the Feedwater venturis, and uses this information in the calculation of the reactor thermal power. Key input parameters include feedwater flow, feedwater temperature, blowdown flow, steam pressure, tempering flow for the D5 Steam Generators, etc.

Calorimetric calculations are performed routinely to determine reactor power. Inputs from various plant instruments are used in this calculation. A significant input parameter to the calorimetric calculation is Feedwater flow. The Sensitivity for calorimetric calculations is documented in Calculation NED-0-MSD-8. This calculation also documents the change in reactor power resulting from variation of calorimetric input parameters.

The Nuclear Instrumentation System provides various reactor trip signals for reactor power. The NIS is adjusted using information obtained from the calorimetric calculations of reactor thermal power. The calorimetric power is also used in Peaking factor surveillance, Spent Fuel burn-up, PTLR, Core reactivity surveillance's, Power defect, Xenon history, Preconditioning requirements, ΔT determination, NIS power channel adjustments, S/G duty, and ΔI target determination.

The ultrasonic flow measuring system uses the equipment installed by the DCP's listed in Section 2. The ultrasonic flow measurement uses the sound scattering properties of turbulence rather than using the direct speed of sound travel time via Doppler effect or via phase shifts. Periodically, the permanently installed transducers will be connected to the shared data acquisition/data analyzer and ultra-sonic flow measurements will be obtained. Correction factors will be developed to relate the flow as indicated by the feedwater venturi to that obtained from the ultrasonic measuring system. The correction factors are used in the plant computer calculation of reactor thermal power as well as the daily calorimetric calculation.

7. Describe how the proposed activity will affect plant operation when the changed SSCs function as intended (i.e., focus on system operation/interactions in the absence of equipment failures). Consider all applicable operating modes. Include a discussion of any changed interactions with other SSCs. For a test or experiment, discuss the impact on the safe operation of the plant of any new technique or new system configuration.

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Tracking No. 6G-00-0079

The use of the ultrasonic Feedwater flow measuring equipment, in-and-of-itself, has no affect on nuclear safety. Periodically, the data acquistion/data analyzer will be connected to the permanently installed transducers, and the Feedwater flow measurement obtained. It is only when this data is used to correct the Feedwater flow as measured by the Feedwater venturis in the plant calorimetric calculations and the determination of reactor thermal power that nuclear safety needs to be addressed.

Currently, the reactor thermal power is determined by using the flow information which is obtained from the Feedwater Venturis. Industry operating history has shown that venturi induced errors/bias of feedwater measurement may occur during each fuel cycle. This results in Feedwater flow measurements higher than actually exist. Indication of higher Feedwater flow than actually exists is due to venturi induced measurement inaccuracies, and conservatively requires that reactor power be reduced resulting in lost power generation.

The use of ultrasonic flow measurement which is not subject to venturi fouling and other venturi induced measurement uncertainties is used to correct the "Actual Reactor Thermal Power". This correction factor will allow the plant operate closer to the 100% rated thermal power. The development and use of the correction factors will be adminisratively controlled to ensure that the reactor will not operate at levels higher than 100% of its rated thermal power as indicated by the calorimetric power. SPP 00-003(U1) and SPP 00-004(U2) will monitor the systems supporting power operation such as Condensate, Condensate Booster, Heater Drains, Feedwater, Circulating Water, Main Steam, Turbine Speed etc., to ensure that the supporting systems for power operations will not be exposed to operating conditions beyond their design limits for 100% of unit capacity. The scaling changes and setpoint changes required for AMAG implementation are listed in Section 2 and will be completed as part of AMAG implementation. Based upon plant monitoring during the SPP, additional scaling changes, if required, will be implemented.

Since the T_{hot} cannot be increased on Unit 2 due to S/G degradation, the T_{ref}/T_{ave} will have to be decreased. This will be done as part of AMAG implementation. NFM has evaluated(Reference: Letter # PSS:00-024) dropping T_{Ave} from 583 degree F to 582.45 degree F for Unit 2. The initial change in T_{ref}/T_{ave} will be only -0.5 °F to 582.5° F on Unit 2 and no change on Unit 1. This drop in T_{Ave} will allow the delta-T increase from approximately from 58 degree F to 59.1 degree F. Additionally as listed in Section 2, scaling changes for impulse pressure on Unit 1 and 2, and S/G nozzle flow high alarm on Unit 2 will be completed as part of AMAG implementation.

Following AMAG implementation on Unit 2, the unit will initially indicate about 98.5% reactor power. Since there is only about 0.8% bite in the last main turbine governor valve we will need to re-open the unit 2 HP FW heater bypass valve (2FW005) to get to 100% reactor power. The process with which to perform this task will be included in the Unit 2 SPP for AMAG implementation. This will require a change to the M-line up for Unit 2 to reflect the OPEN position of this valve.

The Model for Flow Accelerated Corrosion for secondary side will be modified for new flow following AMAG implementation.

The core analysis, The core peaking factor limits, overpower reactor trip, and spent fuel criticality analysis are not affected by AMAG implementation as described in the following paragraphs.

Calculation NED-I-EIC-0233, Daily power Calorimetric Accuracy Calculation Rev. 1, evaluated the impact of using the AMAG ultrasonic flow instrumentation on the 2% RTP error margin. The conclusion is that the use of the AMAG instrumentation would not increase the total error uncertainty above the 2% error margin. In fact, the use of AMAG decreased the amount of error associated with the flow measurement. Since the error does not exceed the 2% margin, the core analysis is satisfied.

The core peaking factor limits are a function of reactor power, with the most conservative limit being applied at 100 % power. An AMAG adjustment to increase the reactor power(which in past has been understated) would indicate that the previous surveillance has applied a slightly conservative Tech Spec limit. Byron Technical Specification Surveillance measurements include a 4% factor to account for uncertainty in the measurement of Nuclear Enthalpy Rise Channel Factor(F^N_{DH}) and 5% factor to account Heat Flux Hot Channel Factor(F_Q) to account for the uncertainty in the measurement of F_Q. Further explanation is provided in Item 19 of this safety evaluation.

OPEX was reviewed for overpower events. No overpower events were caused by erroneous ultrasonic flow measurements.

The assumed uncertainy in the overpower reactor trip (UFSAR Table 15.0.6) includes a 2% assumed uncertainty (1.25% estimated) during the secondary calorimetric method in the calculated reactor power, and an additional assumed

5% axial power distribution (3% estimated) on the axial power distribution effects on total ion chamber current established quarterly using incore/excore calibration procedure. Any change to the incore/excore current due to small change in reactor power will be less than asssumed uncertainty of 2%.

The Byron spent fuel criticality analysis includes 5% uncertainty in the calculated assembly burnups. This is conservative with respect to the 2% reactor power measurement uncertainty, and as assembly burnup is determined as an integral of reactor power, the 2% uncertainty would bound the reactor power being overstated throughout the fuel's operating history. As long as the reactor power and associated integral fuel burnup are established with a method that satisfy the 2% assumed measurement uncertainty, the criticality analysis is satisfied.

When a potentially defouling condition has occurred, based on the guidance provided in Operator Aid and Operating Procedure BOP FW-25, the reactor operator will set the correction factor back to 1.0, nullifying the affect of the ultrasonic flow measurements and request that a new set of ultrasonic flow measurements be taken. Additionally, based upon plant operating parameters, the reactor operator may at any time elect to set the correction factor back to 1.0 (if less than 1.0) to ensure the conservative, reliable operation of the plant.

The feedwater flow correction factor is only applicable to Mode 1 of plant operation. While the factor is present in the plant computer and is used in the daily calorimetric calculation, it has proportionately less impact at lower power levels. Until more experience is gained under partial power conditions, the AMAG flow correction will be set to 1.0 after a significant load drop has occurred.

The ultrasonic flow measurements are taken periodically and there will be times when the data gathering/data analysis equipment will not be available for reverification of the correction factor. Additionally, industry experience does not support a totally uniform behavior of venturi fouling/defouling mechanisms. To provide an additional degree of conservatism, the minimum correction factor permitted, based on the ultrasonic flow measurements, will be limited to 0.98 until sufficient plant specific behaviors are quantified and correction factors less than 0.98 are justified.

If the average correction factor is calculated to be greater than 1.00, all correction factors shall immediately be set to 1.0 and investigated before any further corrections are applied.

Although the plant has been designed to operate at 100% power, it is possible that the previous efforts to optimize plant equipment performance at previous power levels may result in limitations or alarms as power is increased from current full power levels. The most significant of those have been evaluated and are addressed in the implementation SPP's. Other conditions will be addressed as part of the plant monitoring that will occur during the SPP's.

8 Describe all significant permanent or temporary changes to the words and drawings identified in Step 5 resulting from the proposed change described in Step 3. Describe how the facility or procedure will be different than as currently described.

No changes to the wording as presented in the UFSAR is required for the use of the ultrasonic flow measuring system, the use of the correction factors for Feedwater Venturi fouling, the changes in setpoints listed, or the decrease in Tavg in Unit 2 to support the AMAG change.

NOTE

In some cases, the proposed activity being evaluated may be a candidate for adding words to the UFSAR. Consideration should be given to adding a discussion of key regulatory issues, regulatory documents (Generic Letters, Regulatory Guides, NRC Bulletins, etc.), station commitments and new equipment. (See Regulatory Guide 1.70 for level of detail)

9. Is a permanent change to the UFSAR needed?

☐ YES - UFSAR changes have been initiated via Tracking Control No.: _____

☒ NO -

Proceed to next step

10. Identify each accident or anticipated transient, including LOCA and transient analysis, described in the SAR where any of the following is true:

- The proposed activity alters the initial conditions used in the SAR analysis
- The changed SSC is explicitly or implicitly assumed to function during or after the accident/transient
- Operation or failure of the changed SSC could lead to the accident/transient

The following Accidents/Transients listed below are those that pertain to a feedwater venturi defouling event:

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ACCIDENT/TRANSIENT	SAR SECTION
• Operational Transients	Chapter 15.0
a) Step Load Changes	
b) Ramp Load Changes	
c) Load Rejection up to and including design full load rejection	
• Feedwater System Malfunctions	Chapter 15.1
a) Feedwater System malfunction causing a reduction in Feedwater temperature	
b) Feedwater system malfunction causing an increase in Feedwater flow	
• Loss of Feedwater	Chapter 15.2
a) Loss of external load	
b) Turbine Trip	
c) Loss of Condenser Vacuum and other events that result in Turbine Trip	
d) Loss of normal Feedwater	

Industry experience in the use of ultrasonic flow measuring devices indicates that each of the transients listed above could result in what is termed defouling of the Feedwater venturis. The ultrasonic flow measurements are used to correct for Feedwater venturi fouling and other venturi induced flow measurement uncertainties. In the event of a defouling transient, the use of the correction factor developed from the ultrasonic flow measurements would no longer be appropriate and the correction factor set to unity, removing the effect of the ultrasonic flow measurements until such time as new Feedwater ultrasonic flow measurement data is obtained.

11. May the proposed activity increase the probability of occurrence of any accident or transient, identified in Step 10.

☐ YES ☒ NO

Provide the rationale for the answer for each accident or transient

The proposed activity does not increase the probability of any accidents/transients identified. The use of ultrasonic flow measurements to more accurately determine reactor power by correcting for Feedwater venturi fouling and other venturi induced flow measurement uncertainties will not increase the probability of occurrence of any accident or transient. The ultrasonic flow measurements will be taken periodically; correction factors will be manually input to the plant computer and used in the calorimetric calculations to determine reactor power. There are no control functions or control setpoint features associated with the collection of data, development of the correction factor or use of this factor in the calculation of reactor thermal power. The use of these correction factors does not reduce the reliability of the Feedwater venturis or the plant computer and hence will not result in the probability of occurrence of an accident or transient. Actually, this correction factor will allow the plant operate closer to the 100% rated thermal power. Monitoring of the systems supporting power operation such as Condensate, Condensate Booster, Heater Drains, Feedwater, Circulating Water, Main Steam, Turbine Speed etc., will ensure that the supporting systems for power operations will not be exposed to operating conditions beyond their design limits for 100% of unit capacity. The margin of safety will not be reduced as a result of improving the Feedwater Flow measurement as read by the plant process computer. Since none of these items adversely affects the systems involved in the transients listed in Step 10, the probability of the accident or transient is not increased.

12. May the proposed activity increase the consequences of any accident or transient identified in Step 10.

☐ YES ☒ NO

Provide the rationale for the answer for each accident or transient

Guidance in the form of operating aid and Operating Procedure BOP FW-25 is provided to the Operations personnel for their use in assessing potential transients or events that could result in defouling of the feedwater venturi, and avoid the potential for erroneously operating the reactor above 100% rated thermal power (102% based on calorimetric uncertainties). Maintaining the reactor at 100% of rated thermal power (102% based on calorimetric uncertainties) ensures that the bases for the accident and transient analyses contained in the UFSAR remain valid and are not compromised when the ultrasonic flow measurements are used to correct the reactor thermal power calculations. Maintenance of the accident and transient bases ensures that no increase in the consequences of an accident or transient will occur through the use of the ultrasonic Feedwater flow measurements to correct for Feedwater venturi fouling and other venturi and instrument loop uncertainties.

13. May the proposed activity create the possibility of an accident or transient of a different type than any previously evaluated?

☐ YES ☒ NO

Provide the rationale for the answer considering the descriptions provided in Steps 6, 7, 8, 11, and 12.

Not currently a defined transient, which is of interest, is a defouling event. Industry experience has shown that certain events may result in defouling of the Feedwater venturi. Among these events are load changes of greater than approximately 10% of rated thermal power, changes in Feedwater temperature decreases greater that 15°F, pH excursions, water hammers, etc. The reactor operators easily recognize these events and in such events resulting in defouling, it is clear that use of the ultrasonic Feedwater flow measurement correction factor must be removed. An event that may not be as readily apparent is a spontaneous, partial defouling that is not accompanied by any recognized defouling mechanism. As such, fouling causes an apparent measured increase in Feedwater flow when in fact no change has occurred. This in turn would require the reactor operator to reduce power. A defouling transient would appear as a reduction in reactor power. This event would appear to the reactor operator as a sudden decrease in reactor power with no decrease in electrical output. Here again, guidance in the form of Operator Aid and Operating Procedure BOP FW-25 is provided to the reactor operator to investigate if the partial defouling event has occurred. As with other defouling events, the reactor operator would cease the use of the ultrasonic Feedwater flow measurement correction factor until such time as the ultrasonic flow measurement data could be recollected and a new correction factor developed.

The defouling is not a new accident or transient. After a defouling event, calorimetric reactor power indication is reduced. Operator action would be required based on the single indication of reactor power (calorimetric) to increase reactor power above its previous value.

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14. Describe how the proposed activity will affect equipment failures or malfunctions. Describe any new failure modes and their impact during applicable operating modes and applicable accident or transient conditions.

The use of the ultrasonic flow measurements is merely to correct for inaccurate (overly conservative) Feedwater flow rates obtained from the venturis when fouling and other venturi and instrument loop uncertainties are present. The conservative guidance provided to the reactor operators to discontinue the use of the correction factor in the event that a defouling transient has occurred ensures that the basis for the accident analyses remains valid. The ultrasonic flow measuring equipment is installed external to the Feedwater piping and requires no breach of the pressure boundary. It remains dormant when not in use and is qualified by the vendor for EMI/RFI issues. The AMAG instrumentation will be verified to provide accurate measurement per vendor recommendations prior to its use each time using Station procedures. The physical installation and the use of the correction factor will not affect any equipment failures or malfunctions previously evaluated in the UFSAR.

When the average correction factor is determined to be greater than 1.00 during the ultrasonic test, procedure requires that the correction factors are set to 1.00 and the cause of this condition is investigated. No new failure modes are created. The proposed activity will not affect the operation of the equipment during applicable operating modes and applicable accident /transient conditions (Feedwater system malfunction causing an increase in Feedwater flow in 15.1) remain bounded for these conditions.

15. May the proposed activity increase the probability of occurrence of a malfunction of equipment important to safety identified in Step 14?

☐ YES ☒ NO

Provide the rationale for the answer for each malfunction described in Step 14.

The ultrasonic flow measurement system has no direct interface with the plant. The data collection of the ultrasonic flow measurements uses dedicated separate equipment, which has no interface (except 120V AC power temporarily during data gathering) with any plant system, or equipment. The correction factor is manually input and has no control function. Guidance in the form of an Operator Aid and Operating Procedure BOP FW-25 is provided to operations personnel ensure that the factor to correct for fouling of the Feedwater venturi is not used in the event a potentially defouling transient occurs. Cessation of the use of the correction factor, the lack of interface with plants systems, equipment or components and the benign nature of the physical installation ensure that this proposed activity will not increase the probability of a malfunction of equipment important to safety.

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16. May the proposed activity increase the consequences of a malfunction of equipment important to safety identified in Step 14?

☐ YES ☒ NO

Provide the rationale for the answer for each malfunction described in Step 14.

As stated in Step 14, there are no equipment malfunctions affected by the use of the ultrasonic flow measurements or the correction factor used to negate the effects of fouling of the Feedwater venturis. There is no direct interface with any equipment important to safety.

17. May the proposed activity create the possibility of a different type of malfunction of equipment important to safety than any previously evaluated?

☐ YES ☒ NO

Provide the rationale for the answer considering the descriptions provided in Steps 6, 7, 8, and 14.

The ultrasonic flow measurement system has no direct interface with the plant. The data collection of the ultrasonic flow measurements uses dedicated, separate equipment, which has no direct interface with any plant system, component or equipment. The ultrasonic flow measuring equipment is installed external to the Feedwater piping and requires no breach of the pressure boundary, sits dormant when not in use and qualified by the vendor for EMI/RFI issues. The guidance in the form of an Operating Aid and Operating Procedure BOP FW-25 provided to the operations personnel ensure that the use of the defouling correction factor will be stopped in the event that a potentially defouling transient were to occur. Cessation of the use of the defouling correction factor ensures that the 100% reactor thermal power operating limit is not violated. Based on the discussion above, the proposed activity will not create the possibility of a different type of malfunction of equipment important to safety than those previously evaluated.

18. List each Technical Specification where the requirement, associated action items, associated surveillance's, or bases may be affected. To determine the factors affecting the specification, it is necessary to review the SAR, including approved pending UFSAR changes, where the Bases Section of the Technical Specifications does not explicitly state the basis.

Technical Specification	Acceptance Limit(s)/Margin of Safety	SAR Documents & Section
2.1.1, Reactor Core SLs	Figure 2.1.1-1	B2.1.1; UFSAR 4.4, 5.1, 15.0
3.1.2, Core Reactivity	The reactivity balance limit ensures that plant operation	B3.1.2; FSAR Chapter 15

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	is maintained within the assumption of the safety analysis.	
3.2.1, Heat Flux Channel Factor(F_Q)	The $F_Q(Z)$ limits must be maintained in Mode 1 to prevent core power distributions from exceeding the limits assumed in the safety limits.	B3.2.1; UFSAR 15.4.8
3.2.2, Nuclear Enthalpy Rise Hot Channel Factor($F^N_{\Delta H}$)	$F^N_{\Delta H}$ shall be maintained within the limits of the relationship provided in the COLR. $F^N_{\Delta H}$ limit identifies the coolant flow channel with the maximum enthalpy rise. This channel has the greatest relative heat generation with fixed heat removal capability and thus has highest probability for DNB.	B3.2.2; UFSAR 15.4.8
3.2.3, Axial Flux Difference(AFD)	AFD requirements are applicable in Mode 1 above power level 15% RTP. Above 50%RTP, the combination of thermal power and core peaking factors are the core parameters of primary importance in safety analyses. Between the 15% and 90% RTP, the LCO provides penalty deviation time limits to ensure that the distributions of xenon are consistent with safety analysis assumptions	B3.2.3; UFSAR Section 7.7.1.3.1
3.3.1, Reactor Trip System Instrumentation, Table 3.3.1-1	Safety Margin is incorporated into the Allowable Values for reactor Trip setpoints.	B3.3.1
3.4.1, RCS Pressure,	LCO 3.4.1 requires RCS	B3.4.1; UFSAR 4.4, 5.1,

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Temperature, and Flow Departure from Nucleate Boiling (DNB) Limits	total flow rate ≥ 371,400 gpm. Accident analyses using the Revised Thermal Design Procedure assume an initial nominal 366,000 gpm RCS flow rate. For accident analyses not using the Revised Thermal Design Procedure an initial nominal RCS flow of 358,800 gpm. These thermal design flow rates are 5.7% - 6.7% lower than actual operational flow rates (best estimate flow).	15.0; SER 4.4.1
3.4.3, RCS Pressure and Temperature(P/T) Limits	Each PTLR provides P/T limit curves for heatup, cooldown, Inservice Leak and Hydrostatic(ISLH) testing and data for maximum rate of change of reactor coolant temperature	B3.4.3; UFSAR
3.7.16, Spent Fuel Assembly Storage	K_{eff} of Spent Fuel Pool will always remain < 1.00 assuming that the pool is flooded with unborated water and less than or equal to 0.95 assuming the presence of 550 PPM soluble boron in the pool for the Joseph Oat Spent Fuel pool Storage Racks, and assuming the pool is flooded with unborated water for Holtec Spent pool Storage Racks.	B3.7.16

19. Does the proposed activity reduce the margin of safety as described in the basis for any technical specification?

☐ YES – Margin of Safety IS reduced.
☒ NO - Margin of Safety is NOT reduced.

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Provide the rationale for the answer each Technical Specification.

A Venturi defouling event will result in an actual indicated calorimetric thermal power reading lower than actual.

When the calorimetric correction factor is not installed, subsequent reactor power adjustments following a defouling event will recover thermal power that was not apparent due to fouling (a clean venturi condition).

If the calorimetric software correction factor has been added, based on ultrasonic flow measurements, and a later defouling event occurs at a RTP of 100%, any subsequent manual adjustment based on the RTP reading has the potential for actual thermal power to exceed our operating license limit of 3411 MW_t. Since the Power Range Nuclear Instrumentation (PRNIs) are unaffected by the defouling event, the reactor power increase could bias up the PRNI indicated power and the reactor trip setpoints. This bias would reduce the margin between the trip setpoint and the Allowable Values. Any subsequent PRNI gain adjustment based on a calorimetric surveillance would remove/reduce the unconservatism in the trip setpoints, but would reduce the operation margin to the trip setpoints.

Defouling events are recognized by the fact that they are typically attributed to plant transients. In addition, the plant process computer indication of calorimetric power is very sensitive to any changes in plant conditions that can induce a defouling event. Procedural mechanisms and operator aids are incorporated in the changes introduced under this safety evaluation to assist in the recognition of a potential venturi defouling event. The procedures will direct operator actions to remove the calorimetric software correction factor provided by the ultrasonic flow measurements prior to making any reactor power adjustments. Ultrasonic feedwater flow measurements will be re-performed prior to re-inserting any calorimetric correction factor.

The compensation provided by the ultrasonic feedwater flow measurements compensates for fouling and other venturi measurement inaccuracies. The expected disparity between actual thermal power and indicated thermal power attributed to defouling will not result in exceeding a Safety Limit based on the margin available while operating at 100% programmed T_{Ave}, rated thermal power, and conservative RCS pressures. Since the ultrasonic feedwater flow measurements also compensate for venturi inaccuracies, it is likely that the disparity between actual thermal power and indicated thermal power will be enveloped by this difference and within the 100±2% calorimetric error assumed in accident analyses. Since the procedures and operator aids will provide a mechanism to recognize a defouling event and remove the venturi compensations prior to adjusting reactor power, it is not likely that a Safety Limit will be exceeded. A similar rationale can be provided for the impact of a defouling event on the margin between reactor trip setpoints and their Allowable Values.

The Technical Specification minimum RCS flow rate of 371,400 gpm assumes RCS flow measurement uncertainties and provides a conservative margin for DNB and non-DNB limiting accidents. The measurement of feedwater flow and the uncertainties associated with this parameter including venturi fouling contribute to the measurement uncertainty of RCS flow. The implementation of the data obtained from the ultrasonic feedwater flow transducers could eliminate a portion of this uncertainty, however it does not change the accident analyses thermal design (i.e., the flows assumed in the accident analysis). In addition, best estimate and actual RCS flow rates are 5.7% - 6.7% greater than the thermal design flow rates. Therefore, there will not be any reduction in the margin of safety associated with RCS flow measurement.

The Applicable Safety Analyses section of the bases for Technical Specification 3.4.1 states that any venturi fouling that might bias the RCS flow rate measurement by greater than 0.1% can be detected by monitoring and trending various plant performance parameters. This statement remains true since the ultrasonic feedwater flow measurements are not impacted by fouling and, therefore, provide a mechanism to trend fouling of the venturis. The correction factors applied to the venturi measurement of feedwater flow to compensate for fouling provides this mechanism. The ultrasonic feedwater flow measurements will not eliminate the requirement to detect and evaluate biasing or to perform precision calorimetric, since it is Byron Station policy to inspect and clean the venturis prior to the performance of a precision calorimetric. Therefore, the bases for Technical Specification 3.4.1 are not affected by the proposed changes.

Calorimetric power is not directly used as part of the calculation of peaking factors F_Q and F^N_{DH} (Tech Spec 3.2.1 & 3.2.2). These peaking factors are measures of relative power. Core burnup is used within the calculation, but the AMAG adjustment effect (~2%) would not cause significant changes to peaking factor measurements. During the performance of the flux map, small changes in reactor power are considered in order to normalize traces to each other. Once the relative peaking factors are calculated, the measured value plus uncertainties is compared to a limit which is dependent upon power (relaxed limit at lower power). The AMAG adjustment has no significant influence on this. The conservative direction for a calorimetric bias is for the calculated value to be higher than actual.

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Calorimetric power is used to determine the fuel assembly burnup (Tech Spec.3.7.16) Assembly burnup is a credit towards the criticality analysis. The administration limit assumes that there is a 3% burnup penalty taken on each bundle. The basis for this 3% is the combined effects of the ability to measure reactor power and the ability to measure individual bundle relative power. The conservative direction for a calorimetric bias is for the calculated value to be lower than actual. The implementation of the AMAG correction implies that the burnup credit applied to old fuel is slightly biased higher than what an AMAG adjusted power would be.

Calorimetric power is used to determine the vessel fluence (Tech Spec. 3.4.3) Fluence calculations and projections are based on relative power distributions and burnup, and burnup is the integral of calorimetric power and time. The conservative direction for a calorimetric bias is for the calculated value to be higher than actual. The implementation of the AMAG correction implies that the fluence is slightly biased higher than what an AMAG adjusted power predicts. This is conservative. The result would result in some margin gains to the fluence, at the percentage equal to the AMAG correction.

Calorimetric power is used to calculate burnup, and burnup is used in the reactivity surveillance (Tech Spec. 3.1.2. However, the purpose of the surveillance is to confirm that burnup related predictions are within tolerance. There are other burnup related values used for tech spec surveillance's such as Estimated Critical predictions (SR 3.1.6.1) and Shutdown Margin (SR 3.1.1.1) among others. The burnup value used for all reactivity and power distributions surveillance's is the same burnup. Therefore, this procedure is partly to validate the burnup-related predictions. There is no conservative direction.

Calorimetric power is used to determine the nominal hot full power nominal delta-T (Tech Spec 3.3.1) and NIS alignment (Tech Spec 3.3.10). However, the nominal value used in the delta-T alignment and NIS alignment is based on the same calorimetric power used to demonstrate compliance with the license limit. A bias in one will result in a bias in the other. The conservative direction is for the calculated value to be greater than the actual.

The Delta-I target is set to the measured delta-I (Tech Spec. 3.2.3) at the measured power. If the power measurement contains a bias, then the administration of the delta-I would be affected by the same bias in such a way that the bias would cancel out.

Therefore, since procedures and operator aids are establish to recognize a defouling event and to initiate actions to remove venturi compensations from ultrasonic feedwater flow measurements, the margin of safety of safety is not

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reduced for any Technical Specification by power output adjustments made based on ultrasonic feedwater flow measurements.

20. Answer all of the following for this change:

Yes	No	
☐	☒	An Unreviewed Safety Question was identified in Questions 11, 12, 13, 15, 16, 17, and/or 19.
☐	☒	This evaluation identified the need to change the Technical Specifications.
☐	☒	This evaluation identified the need to create a new Technical Specification.
☐	☒	This evaluation identified the need for other NRC approval.

If any of the above answers is Yes, proceed to the next step. If all answers were "No", NA the next step and proceed to Step 22.

21. Regulatory Assurance (Provide concurrence or instructions on the course of actions to follow)

N/A Date: N/A
Print/ Signature

22. Assign a Safety Evaluation tracking number and write it on page 1 of this form. Signatures below may be obtained prior to assigning a tracking number.

23. For Safety Evaluations that do not involve an Unreviewed Safety Questions, complete Safety Evaluation Summary Form.

24. I have determined that the documentation is adequate to support the above conclusion.

Preparer: Mahendra Shah / Mahendra Shah Date: 5/8/00
Print / Signature

Dept. / Location: SEC-Mod Design / Byron Phone: 2816

Subject Matter Experts Used (Print Names) Jeff Drowley
Joe Williams Dave Eder

PEPP-E FORM

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Don Hilderbrant/Bob Wunder	Tom Roberts
	Dave Neidich

25. I have determined that the documentation is adequate to support the above conclusion and agrees with the conclusion.

Reviewer: R.J. Niederer / [signature] (Print / Signature) Date: 5-8-00

Dept. / Location: Reactor Engineering / Byron Phone: 3443

26. I agree the Safety Evaluation is ready for use.

Approver: Thomas E Roberts / [signature] (Print / Signature) Date: 5-8-00

Dept. / Location: SEC Engineering / Byron Phone: 4001

27. Preparer shall forward a copy of the Summary Form to the 50.59 Summary Report Coordinator and distribute the Safety Evaluation paperwork in accordance with Station Procedures.

POOR QUALITY ORIGINAL

FEEDWATER VENTURI CALIBRATION
UNIT 1 AND 2

A. PURPOSE and SCOPE

> **NOTE**
> In this procedure, the term Venturi refers to the main Feedwater flow Venturi elements installed on each Steam Generator Feedwater inlet pipe, and the term Ultrasonic refers to the Ultrasonic Feedwater flow elements (AMAG) installed on each Steam Generator Feedwater inlet pipe just upstream of the Feedwater Venturis.

1.0 The purpose of this procedure is to record and evaluate Feedwater flow data obtained from both the Venturi and the Ultrasonic instruments, and if appropriate, determine and implement a Feedwater flow Calibration Multiplier Factor (Multiplier) to be used in all Station calorimetric calculations for both Unit 1 and Unit 2.

2.0 This procedure is executed as required by Thermal Performance Review of unit operating conditions.

B. REFERENCE

1.0 ASME, Fluid Meters, Their Theory and Application, Sixth Edition, 1971

2.0 ASME, Steam Tables – 1967

3.0 BVP 800-43, Feedwater ultrasonic Instrumentation Connection and Disconnection

4.0 AMAG, Crossflow Ultrasonic Flow Measurement User Guide

5.0 AMAG, Unit 1 Initial Test Report, Document 059-PENG-CALC-064, Revision 0

6.0 AMAG, Unit 2 Initial Test Report, Document 159-PENG-CALC-065, Revision 0

7.0 NDIT No. BRW-DIT-99-0141, Determination of an As Found Tolerance and Allowable Value for Feedwater Flow Measurement Instrumentation

8.0 50.59 6G-00-0079

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C. PREREQUISITES

1.0 The Unit is operating in a stable condition before data collection begins.

D. PRECAUTIONS

1.0 The data collection shall be during a period of stable operation above 90% Reactor power. Stability is defined as no change in the following Plant Process Computer points greater than the +- indicated below.

Description	Point	+-	Units
RCS Average Temperature	U0484	1.5	DEG F
First Stage Pressure	P0398	0.6	%
First Stage Pressure	P0399	0.6	%

E. LIMITATIONS AND ACTIONS

1.0 The average Ultrasonic flow during the data collection period has a Margin of Error corresponding to a 95% Confidence Interval no greater than 0.7% when the AMAG data set has an error less than that specified in section 7.2 of the AMAG original test report.

2.0 The uncorrected Venturi Feedwater flow should indicate greater than or equal to the Ultrasonic flow for each Steam Generator, if not consider the following:

2.1 The possibility of erosion occurred in the Venturi.

2.2 Venturi Tap Set damage has occurred.

2.3 Defouling has occurred.

2.4 DP Transmitter calibration drift.

3.0 If the results of the Operational Test shown in Appendix E fail, then contact the equipment vendor for further recommendations and corrective actions. If the Ultrasonic Electronics fails the Operational Test, the system shall not be used to adjust the Feedwater Flow Calibration Multiplier Factor.

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NOTE

If no values have exceeded the Allowable Value Limit then an operability issue does not exist. If one or more values exceed the Allowable Value Limit then an operability issue **MAY** exist and requires immediate I&C Design Engineering evaluation to advise on a proper Operational response.

4.0 If any calculated Ultrasonic / Venturi ratios exceed either the Engineering Evaluation limits, the As-Found Tolerance limits or the Allowable Value limits, as calculated in Appendix B, take the following actions as appropriate:

4.1 If any calculated Ultrasonic / Venturi ratios exceed the **Allowable Value limits** of ≤ 0.9575 or ≥ 1.0425 then **Immediately** perform the following actions:

4.1.1 Do not implement any new Calibration Multiplier Factors.

4.1.2 Notify the Shift Supervisor and instruct them to immediately initiate the use of the emergency value of 1.0 for the FW FLOW CALIB MULTIPLIER points on the Plant Process Computer (K8130, K8131, K8132, K8133) as shown in the Operator Aid "Feedwater Flow Constants". Instruct the Shift Supervisor to reduce reactor power by the maximum FW flow calibration factor per equation {(1-U) * 100] before notify shift supervisor to review for reportability.

4.1.5 Halt procedure execution.

4.2 If any calculated Ultrasonic / Venturi ratios exceed the **As-Found Tolerance limits** of ≤ 0.9750 or ≥ 1.0250 or the 4 loop average correction factor exceeds 2%, then perform the following actions:

4.2.1 Write a PIF indicating that the Feedwater Flow indication has exceeded the As-Found Tolerance and requesting Engineering Evaluation.

4.2.2 Initiate a trending evaluation to determine if an adverse trend exists.

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4.2.3 Collect and evaluate another set of plant and AMAG data.

4.2.4 Review the results with I&C Design Engineering and the System Engineer and using Engineering Judgment obtain approval for implementation of new Calibration Multipliers.

4.3 If any calculated Ultrasonic / Venturi ratios exceed the **Engineering Evaluation limits** of ≤ 0.9900 or ≥ 1.0100 then review the results with the System Engineer and System Engineering Manager and using Engineering Judgment determine if Calibration Multipliers may be implemented.

5.0 This procedure may be used to calculate FW flow calibration multipliers for any or all FW flow loops. If this procedure is being performed on specific flow loops, then only calculate FW flow calibration constants for those loops and use the existing FW flow calibration constants for the other loops in any unit related calculations.

F. MAIN BODY

NOTE

This procedure may be executed entirely by computer. This procedure documents the necessary steps and calculational techniques which must be performed by any executing computer process. As required, this procedure may also be executed by hand. Validation and Verification of computer software may be performed at any time by comparing a hand calculation with a computer-generated calculation.

1.0 Start a new Work Sheet (Appendix B) by entering your name, Unit number and the Date and Time.

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NOTE
Steps F.2 and F.3 may be performed in any order.

2.0 Perform an Operational Test on the Ultrasonic Electronics per Appendix E and determine if the test results are satisfactory. If satisfactory, then indicate on Appendix B and proceed with procedure execution. If not satisfactory, then as required, end or delay this procedure execution and perform necessary Ultrasonic corrective actions to return the Ultrasonic instrument to a serviceable condition. This step may be performed several days in advance.

3.0 Verify/Connect UE to UI per BVP 800-43.

4.0 If the crossflow system is not running perform the following:

4.1 Start the computer, signal condition, and multiplexer

4.2 Start the crossflow system by clicking the icon on the desk top or running the program file
C:\AMAG\cf32m27002\program\cf32m27.exe

5.0 On the CROSSFLOW screen, click the SETUP button. The CHANNEL CONFIGURATION screen will appear.

6.0 On the CHANNEL CONFIGURATION screen, click the LOAD button. The FILE DIALOG screen will appear.

7.0 Load the proper unit's configuration file as follows:

If unit 1 load file c:\byron\unit1\byron_u1.cfg .

If unit 2 load file c:\byron\unit2\byron_u2.cfg

8.0 On the CHANNEL CONFIGURATION screen, click the RETURN button. The CROSSFLOW SCREEN will appear.

9.0 On the CROSSFLOW screen, click the START MEASUREMENT button. The MEASUREMENT INITIALIZATION screen will appear. See sample screen Appendix F, Figure 1.

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10.0 Verify each channel's configuration and settings as follows:

> **NOTE**
> For unit 1 the active channels are 1,3,5, & 7 for FW line A,B,C, & D respectively
> For unit 2 the active channels are 2,4,6, & 8 for FW line A,B,C, & D respectively
> This setup is for human factors so that wrong unit errors can be eliminated.

10.1 On the MEASUREMENT INITIALIZATION screen, select the channel for the "A" FW loop

10.2 Verify the parameters on the MEASUREMENT INITIALIZATION screen per App F.

10.3 If any of the CHANNEL CONFIGURATION parameters do not match Appendix F, follow the AMAG Users Guide and change them so they do match Appendix F.

10.4 Perform steps 10.1 through 10.3 for each active channel.

11.0 On the MEASUREMENT INITIALIZATION screen, click the START button. The FILE DIALOG screen will appear.

12.0 The system will automatically name the AMAG data output files with today's date and time. Write the file name down as this will be used later. Select the proper location for the data files to be stored as follows:

For unit 1 the location should be c:\Byron\Unit1\

For unit 2 the location should be c:\Byron\Unit2\

13.0 Click OK. The system will go to the MEASUREMENT screen and begin to collect data. The system will cycle through the active channels and collect the necessary data.

14.0 When the necessary data is collected, on the MEASUREMENT screen, click the RETURN button. The MEASUREMENT INITIALIZATION screen will appear.

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15.0 At this time copy to disk the four data files just created. The file names created will have the names from step 13 and the extentions ".aXa" where the letter X designates the channel. For unit 1 the four channels will be 1,3,5, & 7. For unit 2 the channels will be 2, 4, 6, & 8.

16.0 Establish a data collection start time and record in Appendix B.

17.0 Collect the Single Collection Plant Process Computer data indicated in Appendix A.

18.0 Collect the Plant Process Computer points indicated in Appendix A for the test period.

19.0 Verify that the Unit maintained greater than 90% RX power and stable operating conditions during the collection period as shown in the Precautions section and check the box in Appendix B. Extend or delay the collection period if/as required to obtain a stable data collection period.

20.0 Calculate the results shown in Appendix B using the formulations and methods shown in Appendix C. These calculations should be performed following these exceptions:

a. Delete all data points with a KLBS/HR flow of less than zero.

b. Delete all data points with a (V1-V2)/P value of greater than 0.25.

c. Delete all data points which are greater than 3 standard deviations off of the average. Perform this 3 standard deviation deletion process three times.

NOTE

The Ultrasonic instrument is certified to deliver a flow indication with an error of no greater than 0.7% if the AMAG data set has an error no greater than that specified in section 7.2 of the AMAG initial test report.

21.0 Record the FW flow ultrasonic error for each loop on Appendix B.

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¢ 22.0 If the average Ultrasonic flow time delay during the data collection period does not have a 95% confidence error of less than or equal to that listed in Section G, then perform the following substeps.

22.1 As required check Ultrasonic instrumentation and extend or delay the collection period if/as required to obtain the required acceptance criteria. Reperform steps F.18 through F.22 as necessary.

22.2 If stable Ultrasonic data can not be obtained, the Test Director may end this procedure here and initiate corrective actions for the Ultrasonic instrument.

23.0 Obtain an independent review of the calculated results and have the reviewer sign and date Appendix B.

24.0 Determine if any Ultrasonic/Venturi ratios exceed either the Engineering Evaluation Limit, the As-Found Tolerance Limit, the Allowable Value Limit, or if the 4 loop average correction factor is greater than 2%, perform the appropriate actions indicated as limitation and actions shown in Section E.4.0.

25.0 Notify Reactor Engineering Group about changes in the calculated Calibration Multiplier Factors. Consult on the expected Calorimetric change resulting from implementing the Factors and a potential need for RTD Alignment following implementation.

26.0 If any value of Calibration Multiplier Differential is less than zero or greater than 0.0005 perform the following sub-steps else the procedure is completed.

26.1 Inform shift to update the FW flow calibration multiplier factors with those created Appendix B.

26.2 Notify the Shift Supervisor that updating the Calibration Multiplier Factors will result in a change to the calculated Calorimetric Power as seen on Plant Computer point U0921.

26.3 Advise the Shift Supervisor to be prepared to adjust Reactor power levels as appropriate. Advise them on the Approximate change in Reactor power as shown on Appendix B.

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26.4 Request Shift Supervisor approval of the Operator Aid.

26.5 Update the NSO Operator Aid Book by replacing the Feedwater Flow Constant Table with a copy of the approved Operator Aid of this procedure.

26.6 Discuss with the Shift Supervisor, their role in the use of the "Emergency" column of the Operator Aid.

G. ACCEPTANCE CRITERIA

1.0 The average time delay as recorded in Appendix E must be between 23.24 and 23.36 miliseconds.

2.0 The average Ultrasonic flow has a 95% confidence error of less than or equal to 0.7% when the AMAG data set time delay has an error (as calculated in Appendix C Formula 6) less than the following table.

	A	B	C	D
U-1	0.2396	0.2067	0.2173	0.2944
U-2	0.2982	0.2318	0.2503	0.1448

Reference Section 7.2 of AMAG initial test report.

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Appendix A

Plant Process Computer Input Data
(Page 1 of 5)

Inputs To Calculations

Single Collection

Description	Units	Point
SG A FT-510 FULL SCALE VALUE	IN. WTR	K8120
SG A FT-511 FULL SCALE VALUE	IN. WTR	K8121
SG A FW FLOW CALIB MULTIPLIER	FRAC	K8130
SG B FT-520 FULL SCALE VALUE	IN. WTR	K8122
SG B FT-521 FULL SCALE VALUE	IN. WTR	K8123
SG B FW FLOW CALIB MULTIPLIER	FRAC	K8131
SG C FT-530 FULL SCALE VALUE	IN. WTR	K8124
SG C FT-531 FULL SCALE VALUE	IN WTR	K8125
SG C FW FLOW CALIB MULTIPLIER	FRAC	K8132
SG D FT-540 FULL SCALE VALUE	IN. WTR	K8126
SG D FT-541 FULL SCALE VALUE	IN. WTR	K8127
SG D FW FLOW CALIB MULTIPLIER	FRAC	K8133
FW VENTURI DESIGN CONSTANT		K8100
BAROMETRIC PRESSURE (NOMIMAL)	PSIA	K8140
STM GEN STEAM QUALITY	FRACTION	K8141
RCS PUMP + MISC HEAT	MWT	K8142
STM GEN BLOWDOWN STATIC HEAD	PSIA	K8143
RX RATED THERMAL POWER	MWT	K8144

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Appendix A

Plant Process Computer Input Data
(Page 2 of 5)

Inputs To Calculations

5 Minute Intervals

Description	Units	EPN	Point
SG A FW PRS	PSIG	PT-FW022	P0403
SG A FW TMP	DEG F	TE-FW026	T0418
SG A FW FLW VNTRI FT-510 DP	IN WTR	FT-510	U8020
SG A FW FLW VNTRI FT-511 DP	IN WTR	FT-511	U8021
SG B FW PRS	PSIG	PT-FW023	P0423
SG B FW TMP	DEG F	TE-FW028	T0438
SG B FW FLW VNTRI FT-520 DP	IN WTR	FT-520	U8022
SG B FW FLW VNTRI FT-521 DP	IN WTR	FT-521	U8023
SG C FW PRS	PSIG	PT-FW024	P0443
SG C FW TMP	DEG F	TE-FW030	T0458
SG C FW FLW VNTRI FT-530 DP	IN WTR	FT-530	U8024
SG C FW FLW VNTRI FT-531 DP	IN WTR	FT-531	U8025
SG D FW PRS	PSIG	PT-FW025	P0463
SG D FW TMP	DEG F	TE-FW032	T0478
SG D FW FLW VNTRI FT-540 DP	IN WTR	FT-540	U8026
SG D FW FLW VNTRI FT-541 DP	IN WTR	FT-541	U8027
RX RC TMP TAVE PMC	DEG F		U0484
TRB HP 1ST STG OUT PRS 1	%	PT-505	P0398
TRB HP 1ST STG OUT PRS 2	%	PT-506	P0399
RX CORE THRM PWR 1 MIN	%		U0921

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Appendix A

Plant Process Computer Input Data
(Page 3 of 5)

Supporting Data
(Test Directors Discretion)

Description	Units	EPN	Point
CNDS BSTR PMP A OUT FLW	KLBS/HR	FT-CB101	F2231
CNDS BSTR PMP B OUT FLW	KLBS/HR	FT-CB102	F2232
CNDS BSTR PMP C FLW	KLBS/HR	FT-CB103	F2233
CNDS BSTR PMP D OUT FLW	KLBS/HR	FT-CB104	F2234
FP A OUT FLW	KLBS/HR	FT-FW004	F2201
FP B OUT FLW	KLBS-HR	FT-FW005	F2202
FP C OUT FLW	KLBS/HR	FT-FW006	F2203
HTR 7 FW OUT PRS	PSIG	PT-508	P0495
HTR 7A FW OUT TMP	DEG F	TE-FW016	T2260
HTR 7B FW OUT TMP	DEG F	TE-FW019	T2261
HTR DRN PMP A OUT FLW	KLBS/HR	FT-HD004	F2211
HTR DRN PMP B OUT FLW	KLBS/HR	FT-HD005	F2212
HTR DRN PMP C OUT FLW	KLBS/HR	FT-HD006	F2213
SG A BD FLW LWR	GPM		F0407
SG A BD FLW UPR	GPM		F0417
SG A FLW BYP	KLBS/HR		F0408
SG A FW FLW TMPRING	GPM	FT-FW251	F2239
SG A FW FLW CORR AVE 1 MIN	KLBS/HR		U0411
SG A FW FLW VENTURI	KLBS/HR		U0609
SG A FW FLW UNCORR 1/2 AVE	KLBS/HR		U0410
SG A FW FLW VNTRI FT-510	VOLTS	FT-510	U9020
SG A FW FLW VNTRI FT-511	VOLTS	FT-511	U9021
SG A FW FLW 1	KLBS/HR	FT-510	F0403
SG A FW FLW 2	KLBS/HR	FT-511	F0404
SG A FW TMP AT FWIV	DEG F	TE-FW233	T2385
SG A FW TMP AUX NOZ	DEG F	TE-FW302	T2353
SG A STM PRS 1	PSIG	PT-514	P0400
SG A STM PRS 2	PSIG	PT-515	P0401
SG A STM PRS 3	PSIG	PT-516	P0402

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Appendix A

Plant Process Computer Input Data
(Page 4 of 5)

Supporting Data
(Test Directors Discretion)

Description	Units	EPN	Point
SG B BD FLW LWR	GPM		F0427
SG B BD FLW UPR	GPM		F0437
SG B FW FLW BYP	KLBS/HR		F0428
SG B FW FLW TMPRING	GPM	FT-FW252	F2240
SG B FW FLW CORR AVE 1 MIN	KLBS/HR		U0431
SG B FW FLW VENTURI	KLBS/HR		U0629
SG B FW FLW UNCORR 1/2 AVE	KLBS/HR		U0430
SG B FW FLW VNTRI FT-520	VOLTS	FT-520	U9022
SG B FW FLW VNTRI FT-521	VOLTS	FT-521	U9023
SG B FW FLW 1	KLBS/HR	FT-520	F0423
SG B FW FLW 2	KLBS/HR	FT-521	F0424
SG B FW TMP AT FWIV	DEG F	TE-FW234	T2386
SG B FW TMP AUX NOZ	DEG F	TE-FW304	T2354
SG B STM PRS 1	PSIG	PT-524	P0420
SG B STM PRS 2	PSIG	FT-525	P0421
SG B STM PRS 3	PSIG	FT-526	P0422
SG C BD FLW LWR	GPM		F0447
SG C BD FLW UPR	GPM		F0457
SG C FW FLW BYP	KLBS/HR		F0448
SG C FW FLW TMPRING	GPM	FT-FW253	F2241
SG C FW FLW CORR AVE 1 MIN	KLBS/HR		U0451
SG C FW FLW VENTURI	KLBS/HR		U0649
SG C FW FLW UNCORR 1/2 AVE	KLBS/HR		U0450
SG C FW FLW VNTRI FT-530	VOLTS	FT-530	U9024
SG C FW FLW VNTRI FT-531	VOLTS	FT-531	U9025
SG C FW FLW 1	KLBS/HR	FT-530	F0443
SG C FW FLW 2	KLBS/HR	FT-531	F0444
SG C FW TMP AT FWIV	DEG F	TE-FW235	T2387
SG C FW TMP AUX NOZ	DEG F	TE-FW306	T2355
SG C STM PRS 1	PSIG	PT-534	P0440
SG C STM PRS 2	PSIG	PT-535	P0441
SG C STM PRS 3	PSIG	PT-536	P0442

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Appendix A

Plant Process Computer Input Data
(Page 5 of 5)

Supporting Data
(Test Directors Discretion)

Description	Units	EPN	Point
SG D BD FLW LWR	GPM		F0467
SG D BD FLW UPR	GPM		F0477
SG D FW FLW BYP	KLBS/HR		F0468
SG D FW FLW TMPRING	GPM	FT-FW254	F2242
SG D FW FLW CORR AVE 1 MIN	KLBS/HR		U0471
SG D FW FLW VENTURI	KLBS/HR		U0669
SG D FW FLW UNCORR 1/2 AVE	KLBS/HR		U0470
SG D FW FLW VNTRI FT-540	VOLTS	FT-540	U9026
SG D FW FLW VNTRI FT-541	VOLTS	FT-541	U9027
SG D FW FLW 1	KLBS/HR	FT-540	F0463
SG D FW FLW 2	KLBS/HR	FT-541	F0464
SG D FW TMP AT FWIV	DEG F	TE-FW236	T2388
SG D FW TMP AUX NOZ	DEG F	TE-FW308	T2356
SG D STM PRS 1	PSIG	PT-544	P0460
SG D STM PRS 2	PSIG	PT-545	P0461
SG D STM PRS 3	PSIG	PT-546	P0462
SG FW FLW F (PPC)	KLBS/HR		U1038

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Appendix B
Work Sheet
Page 1 of 6

Test Director ____________________ Unit __ Date _________ Rx Power ______

Data Collection Start Time _________ End Time _________

Ultrasonic Op Test Ave Time Delay: ___________ Acceptable Range 23.24 to 23.36

Ultrasonic Operational Test Results Satisfactory: [ ] Yes

Rx Power >90% during test period: [ ] Yes

Unit Stable During Data Collection: [ ] Yes

Requirements - No movement greater than the +- indicated

Description	Point	+-	Units
RCS Average Temperature	U0484	1.5	DEG F
First Stage Pressure	P0398	0.6	%
First Stage Pressure	P0399	0.6	%

		Current Data	Initial Test
SG _A FW AMAG Current Data Error %	< initial test report		[ ] yes
SG _B FW AMAG Current Data Error %	< initial test report		[ ] yes
SG _C FW AMAG Current Data Error %	< initial test report		[ ] yes
SG _D FW AMAG Current Data Error %	< initial test report		[ ] yes

________________________________ __________

Review of Calculated Results Date

Ultrasonic / Venturi Ratios Exceed **Engineering Evaluation Limits** [ ] No

If Yes ________________________________ __________

System Engineer – Implementation Approval Date

Ultrasonic / Venturi Ratios Exceed **As-Found Tolerance** [ ] No

If Yes ________________________________ __________

I&C Design Engineer – Implementation Approval Date

__________ PIF Number

Ultrasonic / Venturi Ratios Exceed **Allowable Value Limits** [ ] No

If Yes, Install Emergency 1.0 Calibration Multipliers, Procedure Halt

__________ PIF Number

________________________________ __________

RTD Alignment Review Date

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Appendix B
Work Sheet
(Page 2 of 6)

Collect the data indicated in Appendix A at one minute intervals, then calculate the results below. Determine the averages and calculated values using the formula (#) shown in Appendix C.

Description	Units	Point	Results	
FW VENTURI DESIGN CONSTANT		K8100	______	
BAROMETRIC PRESSURE (NOMINAL)	PSIA	K8140	______	
SG _A FW PRESS average	PSIA	P0403	______	
SG _A FW TEMP average	DEG F	T0418	______	
SG _A FW FLOW CALIB MULTIPLIER	FRC	K8130	______	
SG _A FT-510 FULL SCALE VALUE	IN. WTR	K8120	______	
SG _A FW FLOW VENTURI FT-510 DP average	IN WTR	U8020	______	
SG _A FW FLOW VENTURI FT-510 DP Std Dev	IN WTR		______	(1)
SG _A FT-511 FULL SCALE VALUE	IN WTR	K8121	______	
SG _A FW FLOW VENTURI FT-511 DP average	IN WTR	U8021	______	
SG _A FW FLOW VENTURI FT-511 DP Std Dev	IN WTR		______	(1)
SG _A FW EXPANSION FACTOR			______	(2)
SG _A FW DENSITY	LBS/CF		______	(3)
SG _A FW FLOW VENTURI FT-510 CALC average	KLBS/HR		______	(4)
SG _A FW FLOW VENTURI FT-511 CALC average	KLBS/HR		______	(4)
SG _A FW FLOW VENTURI CALC average	KLBS/HR		______	(5)
SG _A FW FLOW ULTRASONIC average	KLBS/HR		______	
SG _A FW FLOW ULTRASONIC Error	KLBS/HR		______	(6)
SG _A FW FLOW ULTRASONIC Error	%		______	(6)
SG _B FW PRESS average	PSIA	P0423	______	
SG _B FW TEMP average	DEG F	T0438	______	
SG _B FW FLOW CALIB MULTIPLIER	FRAC	K8131	______	
SG _B FT-520 FULL SCALE VALUE	IN WTR	K8122	______	
SG _B FW FLOW VENTURI FT-520 DP average	IN WTR	U8022	______	
SG _B FW FLOW VENTURI FT-520 DP Std Dev	IN WTR		______	(1)
SG _B FT-521 FULL SCALE VALUE	IN WTR	K8123	______	
SG _B FW FLOW VENTURI FT-521 DP average	IN WTR	U8023	______	
SG _B FW FLOW VENTURI FT-521 DP Std Dev	IN WTR		______	(1)
SG _B FW EXPANSION FACTOR			______	(2)
SG _B FW DENSITY	LBS/CF		______	(3)
SG _B FW FLOW VENTURI FT-520 CALC average	KLBS/HR		______	(4)
SG _B FW FLOW VENTURI FT-521 CALC average	KLBS/HR		______	(4)
SG _B FW FLOW VENTURI CALC average	KLBS/HR		______	(5)
SG _B FW FLOW ULTRASONIC average	KLBS/HR		______	
SG _B FW FLOW ULTRASONIC Error	KLBS/HR		______	(6)
SG _B FW FLOW ULTRASONIC Error	%		______	(6)

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Appendix B
Work Sheet
(Page 3 of 6)

Collect the data indicated in Appendix A at one minute intervals, then calculate the results below. Determine the averages and calculated values using the formula (#) shown in Appendix C.

Description	Units	Point	Results	
SG _C FW PRESS average	PSIA	P0443	______	
SG _C FW TEMP average	DEG F	T0458	______	
SG _C FW FLOW CALIB MULTIPLIER	FRAC	K8132	______	
SG _C FT-530 FULL SCALE VALUE	IN. WTR	K8124	______	
SG _C FW FLOW VENTURI FT-530 DP average	IN WTR	U8024	______	
SG _C FW FLOW VENTURI FT-530 DP Std Dev	IN WTR		______	(1)
SG _C FT-531 FULL SCALE VALUE	IN WTR	K8125	______	
SG _C FW FLOW VENTURI FT-531 DP average	IN WTR	U8025	______	
SG _C FW FLOW VENTURI FT-531 DP Std Dev	IN WTR		______	(1)
SG _C FW EXPANSION FACTOR			______	(2)
SG _C FW DENSITY	LBS/CF		______	(3)
SG _C FW FLOW VENTURI FT-530 CALC average	KLBS/HR		______	(4)
SG _C FW FLOW VENTURI FT-531 CALC average	KLBS/HR		______	(4)
SG _C FW FLOW VENTURI CALC average	KLBS/HR		______	(5)
SG _C FW FLOW ULTRASONIC average	KLBS/HR		______	
SG _C FW FLOW ULTRASONIC Error	KLBS/HR		______	(6)
SG _C FW FLOW ULTRASONIC Error	%		______	(6)
SG _D FW PRESS average	PSIA	P0463	______	
SG _D FW TEMP average	DEG F	T0478	______	
SG _D FW FLOW CALIB MULTIPLIER	FRAC	K8133	______	
SG _D FT-520 FULL SCALE VALUE	IN WTR	K8126	______	
SG _D FW FLOW VENTURI FT-540 DP average	IN WTR	U8026	______	
SG _D FW FLOW VENTURI FT-540 DP Std Dev	IN WTR		______	(1)
SG _D FT-541 FULL SCALE VALUE	IN WTR	K8127	______	
SG _D FW FLOW VENTURI FT-541 DP average	IN WTR	U8027	______	
SG _D FW FLOW VENTURI FT-541 DP Std Dev	IN WTR		______	(1)
SG _D FW EXPANSION FACTOR			______	(2)
SG _D FW DENSITY	LBS/CF		______	(3)
SG _D FW FLOW VENTURI FT-540 CALC average	KLBS/HR		______	(4)
SG _D FW FLOW VENTURI FT-541 CALC average	KLBS/HR		______	(4)
SG _D FW FLOW VENTURI CALC average	KLBS/HR		______	(5)
SG _D FW FLOW ULTRASONIC average	KLBS/HR		______	
SG _D FW FLOW ULTRASONIC Error	KLBS/HR		______	(6)
SG _D FW FLOW ULTRASONIC Error	%		______	(6)

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Appendix B
Work Sheet
(Page 4 of 6)

Using formula (7) calculate the Ultrasonic / Venturi ratios and determine if any exceed either the Engineering Evaluation limit (EE), the As-Found Tolerance (AF) or the Allowable Value (AV). Refer to the Limitations and Actions section of the procedure for more details.

	AV 0.9575	AF 0.9750	EE 0.9900 ≤		EE ≥ 1.0100	AF 1.0250	AV 1.0425
SG _A UT / FT-510	[ ]	[ ]	[ ]	________	[ ]	[ ]	[ ]
SG _A UT / FT-511	[ ]	[ ]	[ ]	________	[ ]	[ ]	[ ]
SG _B UT / FT-520	[ ]	[ ]	[ ]	________	[ ]	[ ]	[ ]
SG _B UT / FT-521	[ ]	[ ]	[ ]	________	[ ]	[ ]	[ ]
SG _C UT / FT-530	[ ]	[ ]	[ ]	________	[ ]	[ ]	[ ]
SG _C UT / FT-531	[ ]	[ ]	[ ]	________	[ ]	[ ]	[ ]
SG _D UT / FT-540	[ ]	[ ]	[ ]	________	[ ]	[ ]	[ ]
SG _D UT / FT-541	[ ]	[ ]	[ ]	________	[ ]	[ ]	[ ]
AVERAGE	(Between 0.98 and 1.02)			________	Yes / No		

If any Allowable Value (AV) limits are exceeded IMMEDIATELY perform the following:

Do not implement any new Calibration Multiplier Factors. Notify the Shift Supervisor and instruct them to immediately initiate the use of the emergency value of 1.0 for the FW FLOW CALIB MULTIPLIER points on the Plant Process Computer (K8130, K8131, K8132, K8133) as shown in the Operator Aid "Feedwater Flow Constants". Instruct the Shift Supervisor to adjust power as indicated by the change in the one minute Calorimetric computer point, U0921 after implementing the emergency values of 1.0.

Write a PIF indicating that the Feedwater Flow indication has exceeded the Allowable Value and request immediate I&C Design Engineering Evaluation.

Halt procedure execution.

Note: If no values have exceeded the AV then an operability issue does not exist. If one or more values exceed the AV then an operability issue MAY exist and requires immediate I&C Design Engineering evaluation to advise on a proper Operational response.

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Appendix B

Work Sheet
(Page 5 of 6)

If any As-Found (AF) Tolerance limits ARE exceeded or the 4 loop average correction is greater than 2%, perform the following:

Write a PIF indicating that the Feedwater Flow indication has exceeded the As-Found Tolerance and requesting Engineering Evaluation.

Initiate a trending evaluation to determine if an adverse trend exists.

Collect and analyze another set of data.

Review the results with I&C Design Engineering and the System Engineer and using Engineering Judgment obtain approval for implementation of new Calibration Multipliers.

If any Engineering Evaluation (EE) limits are exceeded perform the following:

Review the results with the System Engineer and using Engineering Judgment determine if Calibration Multipliers may be implemented.

Calculate average Ultrasonic / Venturi ratios for each SG FW line. These values become the New Calibration Multiplier Factors:

SG _A FW FLOW CALIB MULT	FRAC (K8130)	____________(7)
SG _B FW FLOW CALIB MULT	FRAC (K8131)	____________(7)
SG _C FW FLOW CALIB MULT	FRAC (K8132)	____________(7)
SG _D FW FLOW CALIB MULT	FRAC (K8133)	____________(7)

Implementation Determination:

SG _A CALIB MULT DIFFERENTIAL	__________(8)	< 0.0 or > 0.0005	[ ] yes
SG _B CALIB MULT DIFFERENTIAL	__________(8)	< 0.0 or > 0.0005	[ ] yes
SG _C CALIB MULT DIFFERENTIAL	__________(8)	< 0.0 or > 0.0005	[ ] yes
SG _D CALIB MULT DIFFERENTIAL	__________(8)	< 0.0 or > 0.0005	[ ] yes

If any of the above differentials are marked yes, then replace the Feedwater Flow Constant Table page in the Operator Aid – "Feedwater Flow Constants" and update the Calibration Multiplier Factors by setting Plant Process Computer points K8130, K8131, K8132, K8133.

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Appendix B

Work Sheet
(Page 6 of 6)

Calculate the approximate expected power changes upon implementation of the new Calibration Multiplier Factors.

Total FW flow as measured with the constants of 1.00 and the Venturi	________	KBH
Total FW flow as measured with the old constants and the Venturi	________	KBH
Total FW flow as measured with AMAG	________	KBH
Expected % Reactor Power Indication Change on Implementation	________	(9)
Expected MWe Gross Generation Change on Power Adjustment	________	(9)

If the above Expected % Reactor Power indication change is a positive value, then notify the Shift Supervisor and advise them on the conditions. As a conservative measure, the Shift Supervisor shall adjust power downward by the amount indicated until final approval and implementation of the Operator Aid revision.

RCS Flow Check

Last calculated total RCS flow per 1/2BVSR 4.1.4-1	________	gpm
Record the minimum new FW flow calibration multiplication factor	________	

Perform a check of RCS flow using the following:

RCS flow check with AMAG = Precision RCS flow * Min FW calibration multiplication factor

RCS flow check with AMAG =	________	gpm
Tech Spec minimum RCS flow per LCO 3.4.1	________	gpm

Is the calculated RCS Flow check with AMAG > the Tech Spec minimum YES / NO

If calculated RCS Flow check with AMAG < the Tech Spec Minimum THEN immediately initiate a PIF and notify the Shift Manager that an Operability Issue may exist with RCS Flow and an operability assessment should be performed.

Independent Review

Name ____________________ Date ____________

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Appendix C

Formulas
(Page 1 of 7)

(1) Calculation of DP Transmitter Standard Deviation

Determine for each Venturi DP Transmitter the Standard Deviation of the differential pressure over the test period. The method for calculating Standard Deviations can be found in any Statistic text book.

Std Dev = SUMMATION((DPi – AVEDP)^2 / (N – 1))

Where:	DPi	=	IN.WTR	=	Individual DP Value
	N	=		=	Number of DP Values
	i	=		=	1 through N
	AVEDP	=	IN.WTR	=	Average of all DP Values

If using Excel to perform this calculation, use the Excel function as follows:

Std Dev = STDEV(CellStart : CellEnd)

(2) Calculation of Feedwater Venturi Thermal Expansion Factor

Determine each Steam Generator Feedwater Venturi Thermal Expansion Factor as follows:

FA_s = (2.048E-5 * T_s) + 0.9984

Where:	FA_s	=		=	SG s Venturi Thermal Expansion Factor
	T_s	=	DEG F	=	SG s Feedwater Temperature

(3) Calculation of Feedwater Density

Determine each Steam Generator Feedwater density using ASME Steam Tables and the appropriate Feedwater temperatures and pressures:

DEN_s = Function (T_s, (P_s + PBAR))

Where:	DEN_s	=	LBS/CF	=	SG s Feedwater Density
	T_s	=	DEG F	=	SG s Feedwater Temperature
	P_s	=	PSIG	=	SG s Feedwater Pressure (gauge)
	PBAR	=	PSIA	=	Barometric Pressure (nominal) – K8140

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Appendix C

Formulas
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(4) Calculation of Average Venturi Flow – each of 8 DP Transmitters

Determine each Steam Generator Feedwater base flow using the appropriate Feedwater Venturi differential pressures and constants:

$$WV\underline{st} = (KD * FA\underline{s} * (DP\underline{st} * DEN\underline{s})^{.5}) / (FSV\underline{st}^{.5} * 1000)$$

Where:	$WV\underline{st}$	=	KLBS/HR	=	SG $\underline{s}$ Venturi Calculated flow, DP Transmitter $\underline{t}$
	KD	=		=	Design Constant - K8100
	$FA\underline{s}$	=		=	SG $\underline{s}$ Thermal Expansion Factor
	$DP\underline{st}$	=	IN.WTR	=	SG $\underline{s}$ DP Transmitter $\underline{t}$ Differential Pressure
	$DEN\underline{s}$	=	LBS/CF	=	SG $\underline{s}$ Feedwater Density
	$FSV\underline{st}$	=	IN.WTR	=	SG $\underline{s}$ DP Transmitter $\underline{t}$ Current Full Scale Value

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(5) Calculation of SG Average Venturi Flow

Determine for each Steam Generator the average calculated Venturi Feedwater flow and a total Steam Generator calculated Venturi Feedwater flow.

WVA = (WVA0 + WVA1) / 2
WVB = (WVB0 + WVB1) / 2
WVC = (WVC0 + WVC1) / 2
WVD = (WVD0 + WVD1) / 2

Where:

WVA	=	KLBS/HR	=	SG A FW Flow Venturi Calculated
WVB	=	KLBS/HR	=	SG B FW Flow Venturi Calculated
WVC	=	KLBS/HR	=	SG C FW Flow Venturi Calculated
WVD	=	KLBS/HR	=	SG D FW Flow Venturi Calculated
WVA0	=	KLBS/HR	=	SG A FW Flow Venturi Calculated _FT-510
WVA1	=	KLBS/HR	=	SG A FW Flow Venturi Calculated _FT-511
WVB0	=	KLBS/HR	=	SG B FW Flow Venturi Calculated _FT-520
WVB1	=	KLBS/HR	=	SG B FW Flow Venturi Calculated _FT-521
WVC0	=	KLBS/HR	=	SG C FW Flow Venturi Calculated _FT-530
WVC1	=	KLBS/HR	=	SG C FW Flow Venturi Calculated _FT-531
WVD0	=	KLBS/HR	=	SG D FW Flow Venturi Calculated _FT-540
WVD1	=	KLBS/HR	=	SG D FW Flow Venturi Calculated _FT-541

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(6) Calculation of Ultrasonic Errors

Determine, for each Steam Generator, the Error of the Feedwater flow indicated by the Ultrasonic instrument. The methods described here can be found and detailed in any standard Statistics text book. The discussion which follows assumes that Excel is used to perform these calculations, as follows:

Determine the average KLBS/HR flow value over the test period:

AVE = AVERAGE(CellStart : CellEnd)

Determine the Standard Deviation of the flow values over the test period:

STDEV = STDEV(CellStart : CellEnd)

Determine the number of flow values collected during the test period:

CNT = Count (CellStart : CellEnd)

Determine the Student's T Distribution Critical Value corresponding to a 95% confidence interval. The value of this function can also be found in the tables of most standard Statistic text books. The Excel function is coded as follows:

TDIST = TINV (0.05, CNT – 1)

Determine the KLBS/HR Margin of Error for the flow values collected during the test period.

ERR-KLBS/HR = (TDIST * STDEV) / SQRT(CNT)

Determine the Percent Margin of Error for the flow values collected during the test period.

ERR-% = ERR-KLBS/HR * 100 / AVE

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(7) Calculation of Ultrasonic / Venturi Ratios

Determine for each Venturi DP transmitter a new Ultrasonic / Venturi Ratio and for each Steam Generator Feedwater Venturi determine the average Ultrasonic / Venturi Ratio (the Calibration Multiplier value):

$$CM\underline{st} = WU\underline{s} / WV\underline{st}$$

$$CM\underline{s} = (CM\underline{s}0 + CM\underline{s}1) / 2$$

Where:

$CM\underline{st}$	= fraction	= SG $\underline{s}$ DP Transmitter $\underline{t}$ Ratio
$CM\underline{s}$	= fraction	= SG $\underline{s}$ FW Flow Calibration Multiplier Value
$Wu\underline{s}$	= KLBS/HR	= SG $\underline{s}$ FW Flow Ultrasonic Indicated
$WV\underline{st}$	= KLBS/HR	= SG $\underline{s}$ FW Flow Venturi Calculated DP Transmitter $\underline{t}$

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(8) Calculation of Calibration Multiplier Differentials

Determine for each Steam Generator Feedwater Venturi a Calibration Multiplier Differential Value:

DCMA = PCMA - CMA
DCMB = PCMB - CMB
DCMC = PCMC - CMC
DCMD = PCMD - CMD

Where:	DCMA	=	fraction	=	SG A Calib Mult Differential
	DCMB	=	fraction	=	SG B Calib Mult Differential
	DCMC	=	fraction	=	SG C Calib Mult Differential
	DCMD	=	fraction	=	SG D Calib Mult Differential
	PCMA	=	fraction	=	Previous SG A FW Flow Calib Mult Value - K8130
	PCMB	=	fraction	=	Previous SG B FW Flow Calib Mult Value - K8131
	PCMC	=	fraction	=	Previous SG C FW Flow Calib Mult Value - K8132
	PCMD	=	fraction	=	Previous SG D FW Flow Calib Mult Value - K8133
	CMA	=	fraction	=	SG A FW Flow Calib Mult Value
	CMB	=	fraction	=	SG B FW Flow Calib Mult Value
	CMC	=	fraction	=	SG C FW Flow Calib Mult Value
	CMD	=	fraction	=	SG D FW Flow Calib Mult Value

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(9) Calculation of Approximate Reactor Indicated Power Change Upon Implementation of Calibration Multiplier Factors

$$RX = \frac{Total\ AMAG\ Flow}{Total\ Venturi\ Flow} * 0.988$$

Determine the **Approximate** change in indicated Reactor power if the currently calculated Calibration Multiplier Factors are implemented. A positive value indicates indicated power level will increase and a negative value indicates power level will decrease:

DRX = RX - PRX

Determine the **Approximate** change in gross generation upon adjusting power to the value as indicated using the new Calibration Multiplier Factors. A positive value indicates an increase in generation and a negative a decrease in generation.

DMWE = DRX * 1175 ÷ 100

Where:

PRX	=	%	=	Previous Reactor Power Level
RX	=	%	=	Current Reactor Power Level
DRX	=	%	=	Delta Rx Power with New Calib Mult Factors

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Appendix D

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Appendix E

Ultrasonic Electronics Operational Test
(Page 1 of 3)

This test verifies that the Ultrasonic Electronics Systems (UE) and software are responding properly.

The results of this test should indicate an output time delay within +-0.1 milliseconds of the original instrument test values. If UE test time delays are found to be outside this range, contact the equipment vendor for further recommendations and corrective actions. If the UE fails this test it shall not be used to adjust the Feedwater Flow Calibration Multiplier Factor determined by this procedure.

Testing Procedural Steps

1. Turn on the Signal Conditioner (SC) and the PC Computer (PC) and allow them to warm up for a minimum of 15 minutes.

2. Start the CROSSFLOW software by clicking on the CROSSFLOW icon or running the program file c:\amag\cf32m27002\program\cf32m27.exe. The CROSSFLOW screen will appear.

3. On the CROSSFLOW screen, click on the SETUP button. The CHANNEL CONFIGURATION screen will appear.

4. On the CHANNEL CONFIGURATION screen, click on the CONFIG button. A dialog box will appear asking "Do you want to save the flow data acquired while configuring Channel 1?".

5. On the dialog box, click on the NO button. The RANDOM FREQUENCY CONFIGURATION screen will appear.

6. On the RANDOM FREQUENCY CONFIGURATION screen locate a dropdown list box Random Frequency Mode. Click the dropdown button and select Disable Mode.

7. On the RANDOM FREQUENCY CONFIGURATION screen, click on the Finish button. The HARDWARE SETUP screen will appear.

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Appendix E

Ultrasonic Electronics Operational Test
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8. Locate the Panel Switches on the right side of the screen and set the following by clicking on the provided buttons:

   8.1 TRX A to OFF
   8.2 TRX B to OFF
   8.3 LP FILTER to HI (45 Hz)
   8.4 HP Filter to HI (12 Hz)
   8.5 Notch Filter to ON

9. Locate the Sampling Rate dropdown list box near the bottom and center of the screen. Click on the dropdown button and select a Sampling Rate of 1024.

10. Locate the # of Samples dropdown list box just below the Sampling Rate box. Click on the dropdown button and select 4096 as the # of Samples.

11. Locate the Ave.Size box just above the Help button. Set the Ave.Size to 10 by either using the provided up/down arrows or by clicking in the text box and entering 10.

12. Locate the Instantaneous graph area in the upper left area. Locate the Ref box just above this graph and set the Ref to 0.5 by either using the provided up/down arrows or by clicking in the text box and entering 0.5.

13. Locate the Cumulative graph area in the lower left area. Locate the Ref CCV box just above this graph and set the Ref CCV to 0.6 by either using the provided up/down arrows or by clicking in the text box and entering 0.6.

14. Reinitialize the Cumulative graph to default. Using the right mouse button, click and hold the Cumulative graph area. While holding the mouse button, drag the cursor to the dialog box and over the Reinitialize to Default item. Release the mouse button on the Reinitialize to Default entry.

15. Locate the Signal Delay Trend graph area in the lower right area. Reinitialize the Signal Delay Trend graph to default. Using the right mouse button, click and hold the Signal Delay Trend graph area. While holding the mouse button, drag the cursor to the dialog box and over the Reinitialize to Default item. Release the mouse button on the Reinitialize to Default entry.

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16. Locate the Avg Time Delay box just below the Signal Delay Trend graph area. Reinitialize the Avg Time Delay to default. Using the right mouse button, click and hold the Avg Time Delay box. While holding the mouse button, drag the cursor to the dialog box and over the Reinitialize to Default item. Release the mouse button on the Reinitialize to Default entry.

17. Locate the STD (%) box just below the Signal Delay Trend graph area. Reinitialize the STD (%) to default. Using the right mouse button, click and hold the STD (%) box. While holding the mouse button, drag the cursor to the dialog box and over the Reinitialize to Default item. Release the mouse button on the Reinitialize to Default entry.

18. Return to the Panel Switches on the right side of the screen and set the Test Signal to ON.

19. Locate the Reset button located just below the Cumulative graph area. Click on the Reset button.

20. Allow more than 20 consecutive signal delay samples to be recorded in the Signal Delay Trend graph area. This will take about 10-15 minutes. The number of samples appears on the bottom of the signal delay trend graph.

21. Record the millisecond value shown in the Avg Time Delay box on Appendix B, and determine if this value is outside of the range of 23.24 to 23.36 milliseconds.

¢ 22. Based upon the Avg Time Delay value check performed in the above step, do the following:

22.1 If Avg Time Delay is in the specified range, then proceed with the execution of this procedure.

22.2 If Avg Time Delay is outside the specified range, then data obtained from the Ultrasonic system shall not be used to adjust Feedwater Flow Multiplication Factors. Perform other necessary equipment corrective actions (including contacting the vendor) to return the Ultrasonic equipment to working order.

23 Select RETURN at the bottom left of the screen. The "Channel Configuration" will appear.

24. Select RETURN at the bottom of screen. The "Crossflow" main menu will appear.

25. If the operational test done is early and the use wishes to exit the system then select RET at bottom to exit software. If further testing is to be performed return to procedure body.

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APPENDIX F

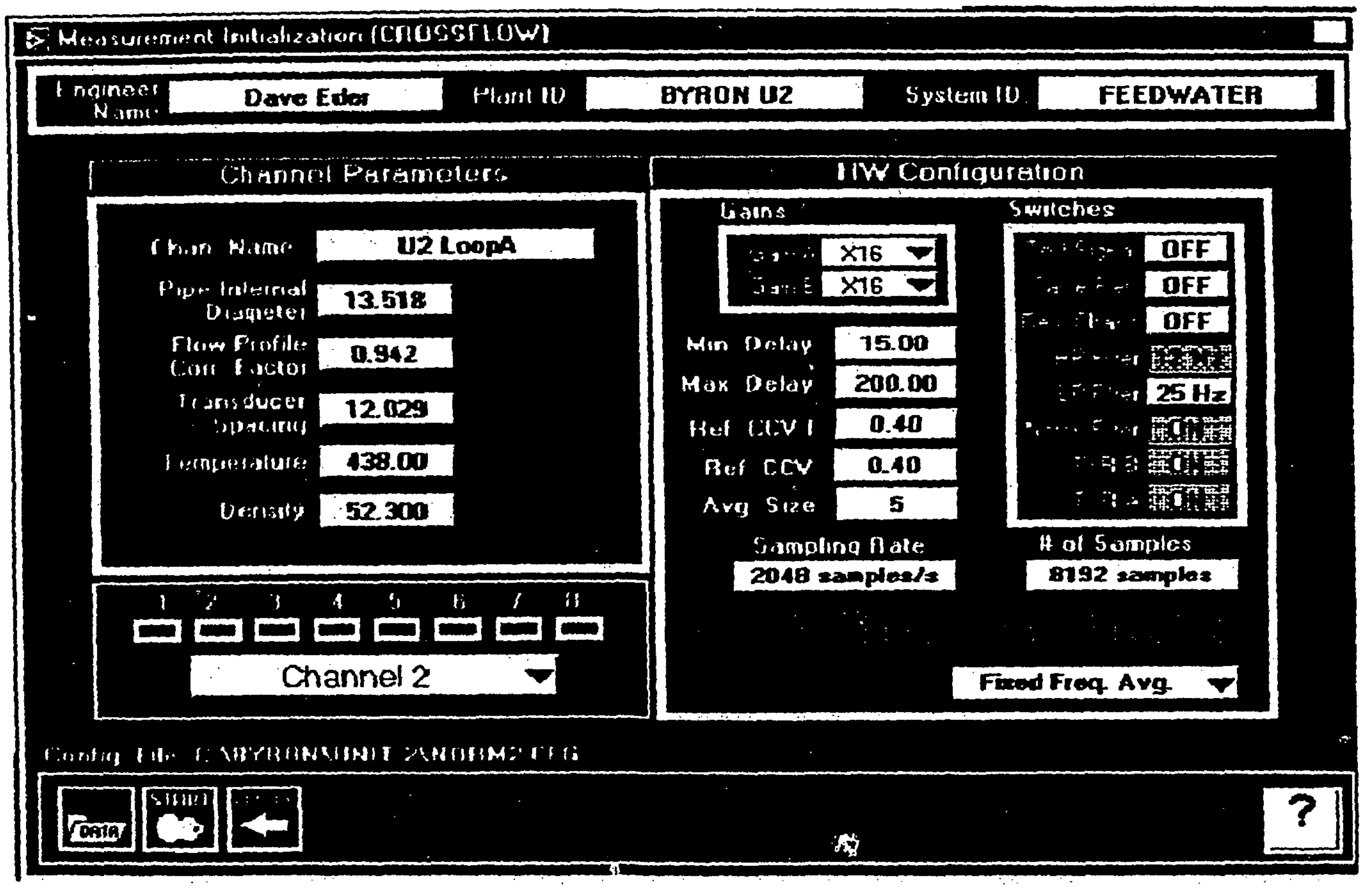

FIGURE 1 – Measurement Initialization Sample Screen

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APPENDIX F
(continued)

	Flow Loop							
	Unit 1				Unit 2			
	A	B	C	D	A	B	C	D
Parameter	Channel 1	Channel 3	Channel 5	Channel 7	Channel 2	Channel 4	Channel 6	Channel 8
Pipe Internal Diameter	13.5954	13.6497	13.6455	13.6574	13.5183	13.6059	13.5824	13.5831
Transducer Spacing	12.0384	12.0314	12.0328	12.0310	12.0289	12.0329	12.0333	12.0324
Min Delay	15	15	15	15	15	15	15	15
Max Delay	200	200	200	200	200	200	200	200
Ref. CCVI	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4
Ref. CCV	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4
Sampling Rate	2048	2048	2048	2048	2048	2048	2048	2048
Test Signal	OFF	OFF	OFF	OFF	OFF	OFF	OFF	OFF
Same Ref.	OFF	OFF	OFF	OFF	OFF	OFF	OFF	OFF
Rev. Chans	OFF	OFF	OFF	OFF	OFF	OFF	OFF	OFF
HP Filter	12 Hz	12 Hz	12 Hz	12 Hz	12 Hz	12 Hz	12 Hz	12 Hz
LP Filter	25 Hz	25 Hz	25 Hz	25 Hz	25 Hz	25 Hz	25 Hz	25 Hz
Notch Filter	ON	ON	ON	ON	ON	ON	ON	ON
TXR B	ON	ON	ON	ON	ON	ON	ON	ON
TXR A	ON	ON	ON	ON	ON	ON	ON	ON
# of Samples	8192	8192	8192	8192	8192	8192	8192	8192

NOTE: Computer display will round to 3 decimal places.

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